J. K. Couchman J. C. MacBean A. Stecher D. F. Wentworth

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Snow and Ice

Examining Your Environment

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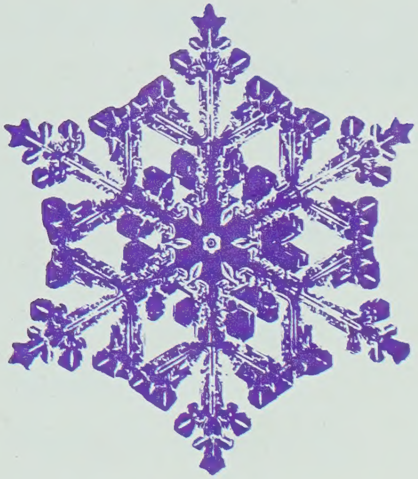
Snow and Ice



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Snow and Ice

Examining Your Environment

J. Kenneth Couchman
John C. MacBean
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Daniel F. Wentworth

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Toronto

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Introduction

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Introduction

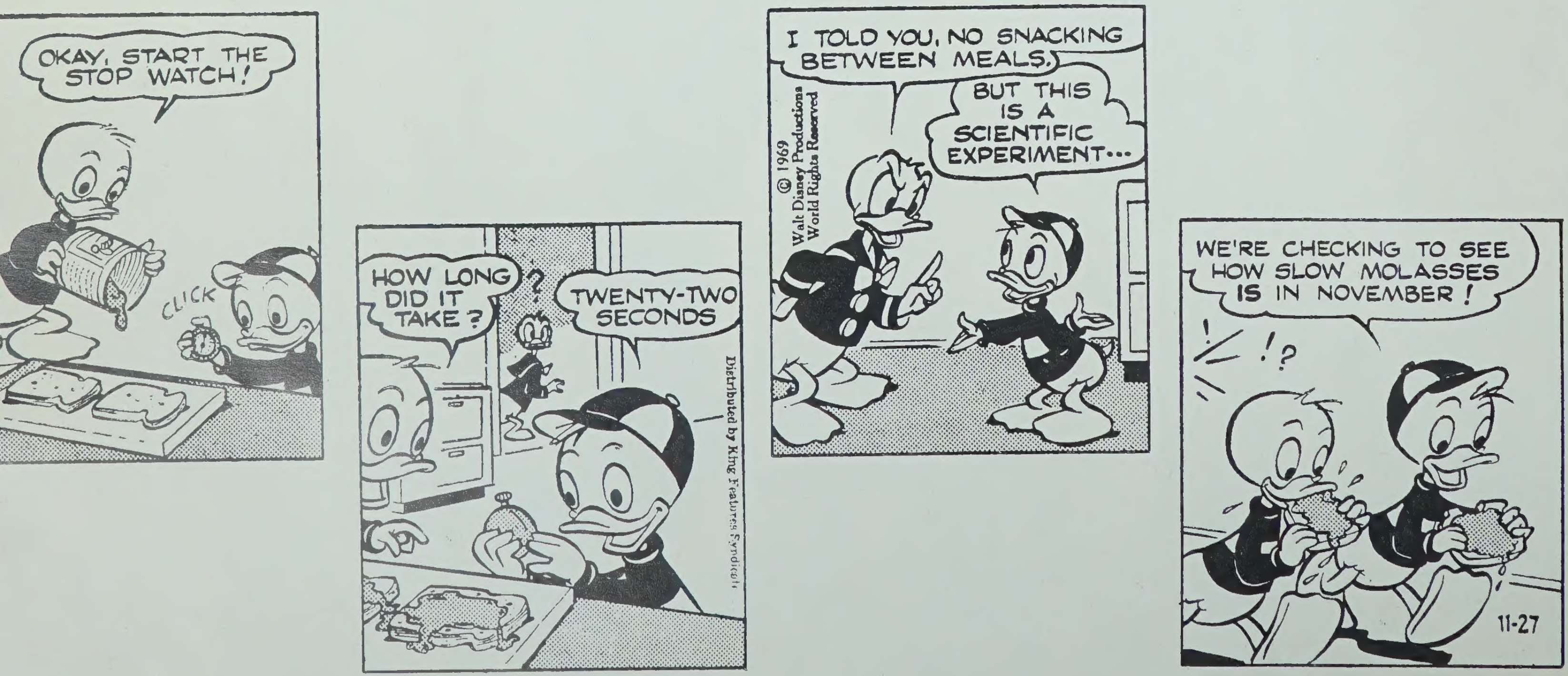
Even in winter the outdoors can be a wonderful place to experience fun and learning. Just because birds have migrated to warmer climates and other animals are hibernating in various holes and crevices are no reasons for boys and girls to feel that during the school day they must be confined within a building. *Snow and Ice* suggests many interesting outside winter activities. As you carry out the investigations you may develop a growing awareness of the wonders of ice and snow.

The winter landscape abounds with unusual and even mysterious sights which very likely you have not even noticed as you rush about your daily affairs. Each chapter of this book has a number of photographs that focus on these scenes. Hopefully they will encourage you to look for other or similar phenomena and start you wondering about their cause.

It is not necessary to have beforehand a great knowledge of winter in order to do the activities in this book. Nor do you need to have available a large number of reference books to assist you in finding answers. In fact, the answers to many of the problems can only be obtained by carrying out the activities. If you do them carefully you will gather first-hand information about snow and ice.

Most of the suggested activities should be conducted outside, on or near the school grounds or your yard. The equipment that is used is easily obtained or can be readily made.

Huey and Dewey seem to be using their knowledge of measurement in a


OKAY, START THE STOP WATCH!
CLICK
HOW LONG DID IT TAKE?
TWENTY-TWO SECONDS
Distributed by King Features Syndicate
© 1969 Walt Disney Productions World Rights Reserved
I TOLD YOU, NO SNACKING BETWEEN MEALS.
BUT THIS IS A SCIENTIFIC EXPERIMENT...
WE'RE CHECKING TO SEE HOW SLOW MOLASSES IS IN NOVEMBER!
!?
11-27

science experiment, even though it is doubtful if they really want to know just how slow molasses is. You will be using measuring techniques similar to the one shown in the cartoon as you become involved with the activities in this book. Measurement helps you to collect data and information which are the basis for drawing conclusions when you are solving a problem. The activities suggest many ways to improve your problem-solving techniques.

Try to work in groups. Before you start, plan carefully the jobs to be done, the equipment needed and the responsibility of each group member. Be certain to consider the way in which the data or information that you collect will be recorded. It may be necessary to prepare data sheets before you start the activity. Many activities should be repeated and the evidence obtained should be averaged. The care with which you do the activity and collect the data will determine your success in finding logical answers.

Do not feel that you must do all of the activities in this book. If one topic or chapter particularly interests you, you may wish to study it in greater depth and omit the other topics. As you work on the problems you may discover others that you want to investigate. Your problems may be much more intriguing than those suggested by the authors. Don't be afraid to investigate them.

After each problem is found a *Digging Deeper* section. This is designed to guide you toward a better understanding of the activity that you have completed and to assist you in interpreting the data that you have collected. The *Branching Out* suggestions provide starting points for investigations related to the problem that you have explored. You may find it interesting to pursue your own in-depth study of some of them.

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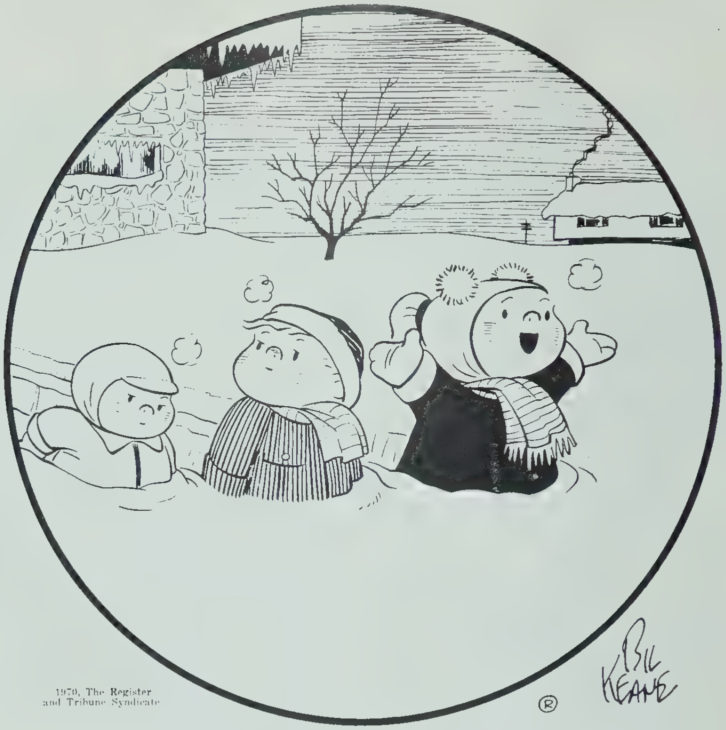
Let it Snow

1

1. Let It Snow!

Snow falls in many forms: fine flurries; fluffy white flakes; driving sleet or drifting walls. To a *meteorologist,* or weatherman, every form of snow is a type of precipitation, which is caused by particular weather conditions. This book deals with winter *phenomena* or wonders. Phenomena are acts occurring in nature that are curious and sometimes cause us to inquire into them for a better understanding. This chapter is mainly concerned with the phenomenon of falling snow.



"And to think this all started with one flake!"

How many snowflakes do you think there are in a cubic metre (a space one metre high, one metre wide and one metre deep)?

In what ways does frozen rain cause hardships during the winter?

Describe how these pieces of equipment will be used after a heavy snowfall.

A magnificent view!

Activity 1:

What is a snowflake?

Place several pieces of black construction paper (15 cm x 15 cm) or black cloth into the freezer compartment of a refrigerator. On a day when snow is falling, take a piece of the paper or cloth outdoors and allow some snowflakes to fall on it. Use a hand magnifier to observe each flake.

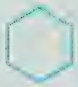
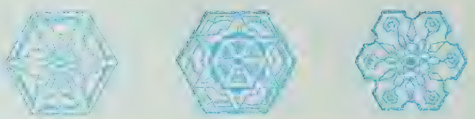
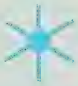
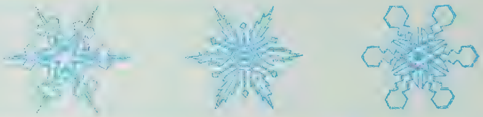
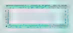
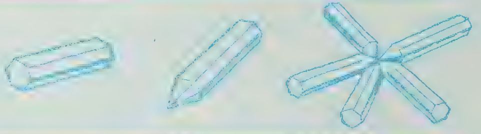
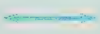
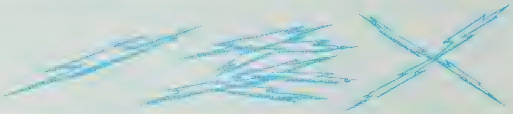
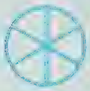
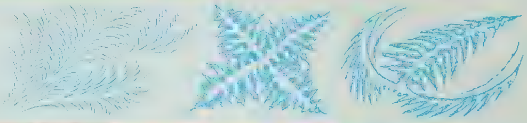
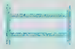
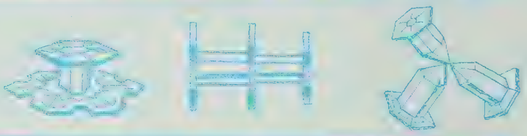
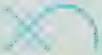
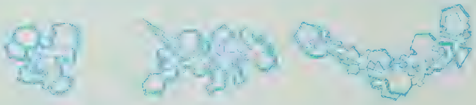
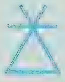
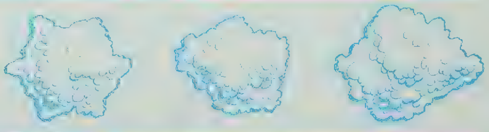
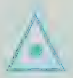
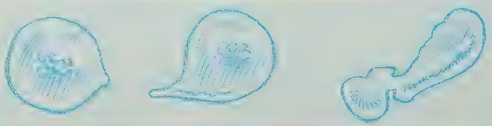
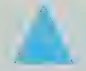
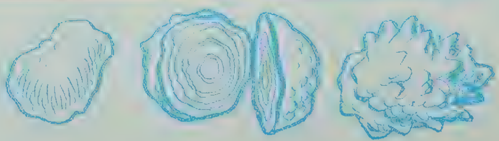
Describe the appearance of the different flakes that you collected.

Are all snowflakes the same shape?

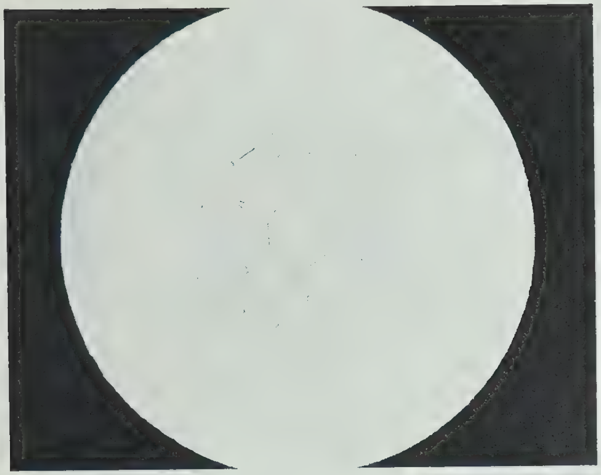
Make a sketch of what you see through the magnifying glass.

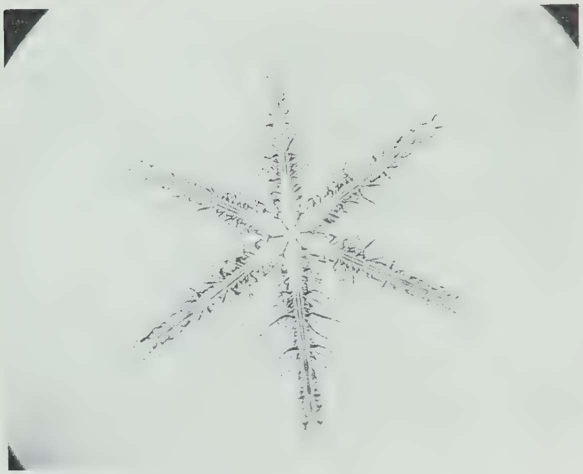
Compare your snowflake shapes with the classification chart of snow and ice crystals. This classification system has been devised after many years of collecting and grouping photographs of snow and ice crystals. There is an endless variety of crystal shapes but all will generally fit into the categories on the chart.

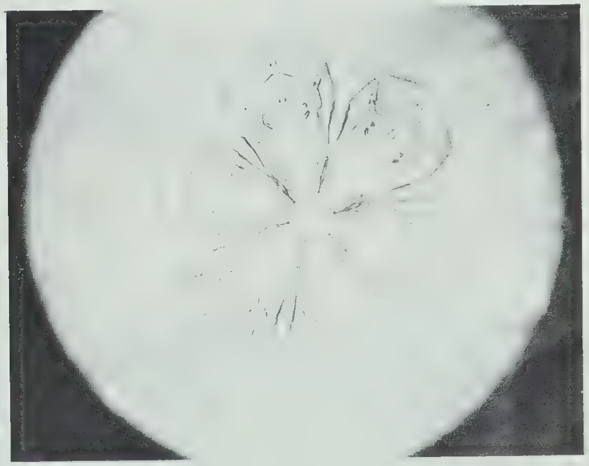
Snow and Ice Crystals

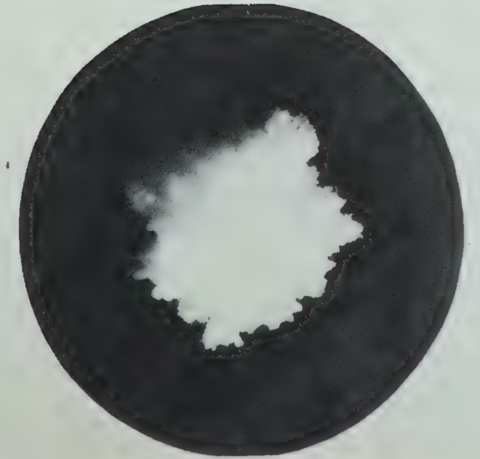
Symbol	Name	Snow and Ice Crystals
	HEXAGONAL PLATES	
	STELLAR CRYSTALS	
	HEXAGONAL COLUMNS	
	NEEDLES	
	SPATIAL DENDRITES	
	CAPPED COLUMNS	
	IRREGULAR CRYSTALS	
	GRAUPEL	
	SLEET	
	HAIL	

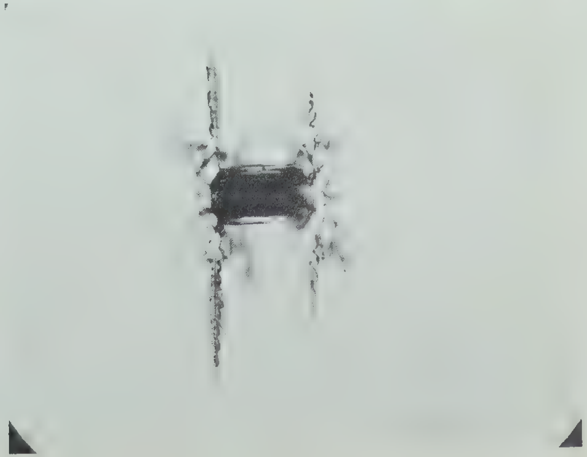
Classify these micro photographs of snowflakes according to the chart.











Why has Snoopy referred to the snow flakes as "the last of the rugged individualists"?

Digging Deeper

Why was it important to place the black construction paper or cloth in the freezer before you collected snowflakes?

With a ruler marked in millimetres find the diameter of your snowflake (the distance across the snowflake). What are the largest and smallest diameters that you found?

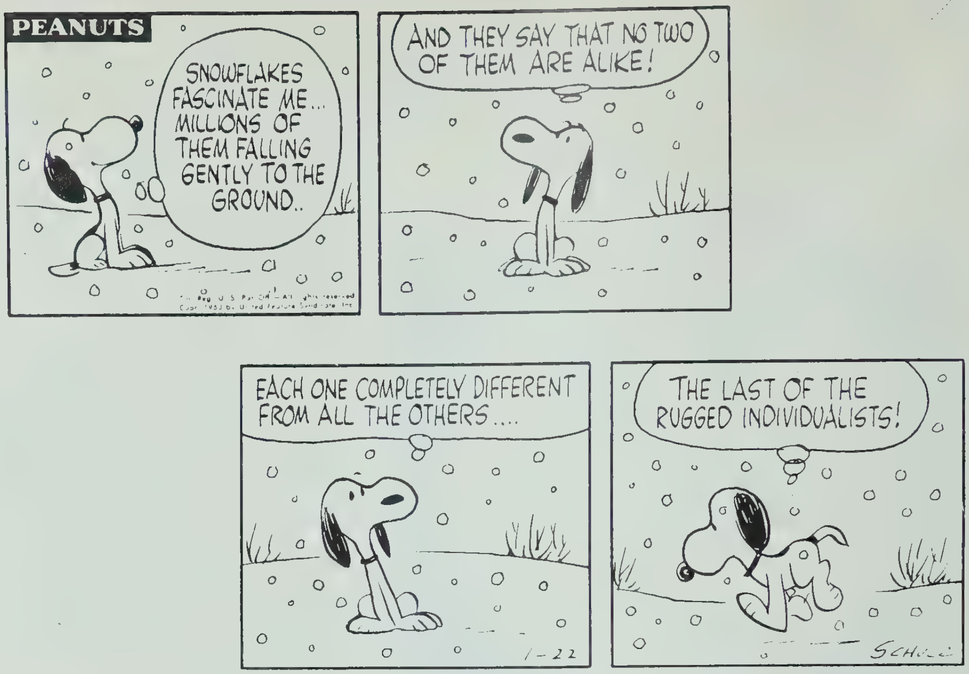
How many different types of snow or ice crystals did you and your classmates discover? Which student found the largest snowflake?

How many sides do snow and ice crystals have?

Branching Out

Who was largely responsible for gathering so much information about snowflakes?

Wilson A. Bentley (1865-1931) was a simple farmer who turned a childhood fascination of natural things into a hobby that made him a world famous expert on snow crystals and their formation. During his lifetime, he developed his technique of *microphotography* and produced some 6000 photographs of snow and ice crystals. Bentley's work became an important source for meteorologists and the United States Weather Bureau, as scientists tried to learn more about snow formation, cloud seeding, and atomic fallout. His two books *Water Wonders* and *Snow Crystals* are records of his lifetime hobby.


PEANUTS
SNOWFLAKES FASCINATE ME... MILLIONS OF THEM FALLING GENTLY TO THE GROUND..
AND THEY SAY THAT NO TWO OF THEM ARE ALIKE!
EACH ONE COMPLETELY DIFFERENT FROM ALL THE OTHERS....
THE LAST OF THE RUGGED INDIVIDUALISTS!
1-22
SCHULZ

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Borrow Bentley's books from your public library and look at some of the famous snowflake microphotographs that he took.

Use a detailed map of Vermont in the United States to locate Jericho, the hometown of "Snowflake" Bentley.

Activity 2:

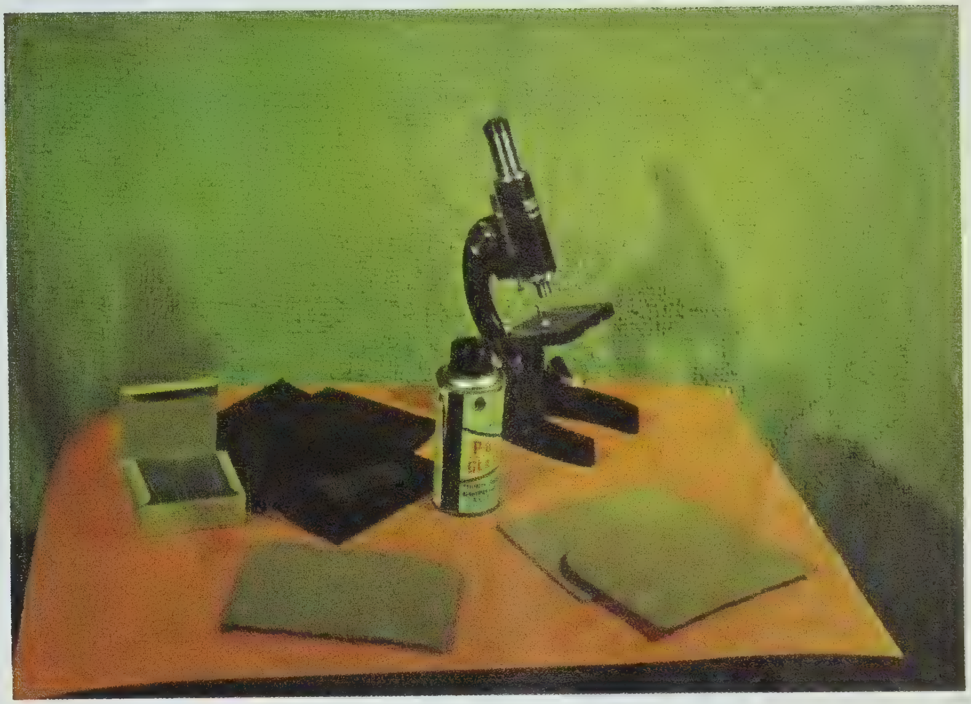
How can snowflakes be collected permanently?

You will need the materials illustrated in the photo.

Place the microscope slides, pieces of corrugated cardboard (10 cm x 10 cm) cut from a cardboard carton and the clear lacquer spray can in the freezer compartment of a refrigerator. After using these items it would be advisable to return them to the freezer in order to be ready for the next snowfall.

At a time when it is snowing, place a slide on a piece of cardboard and take them and the clear lacquer spray can outdoors quickly so that they will not become warm. Avoid touching the glass slide so that your body heat does not warm the glass.

Materials used to collect snowflakes permanently.



Spray a thick layer of clear lacquer on the slide.

It is important to work quickly during this activity.

Let several snowflakes fall on the sprayed surface.

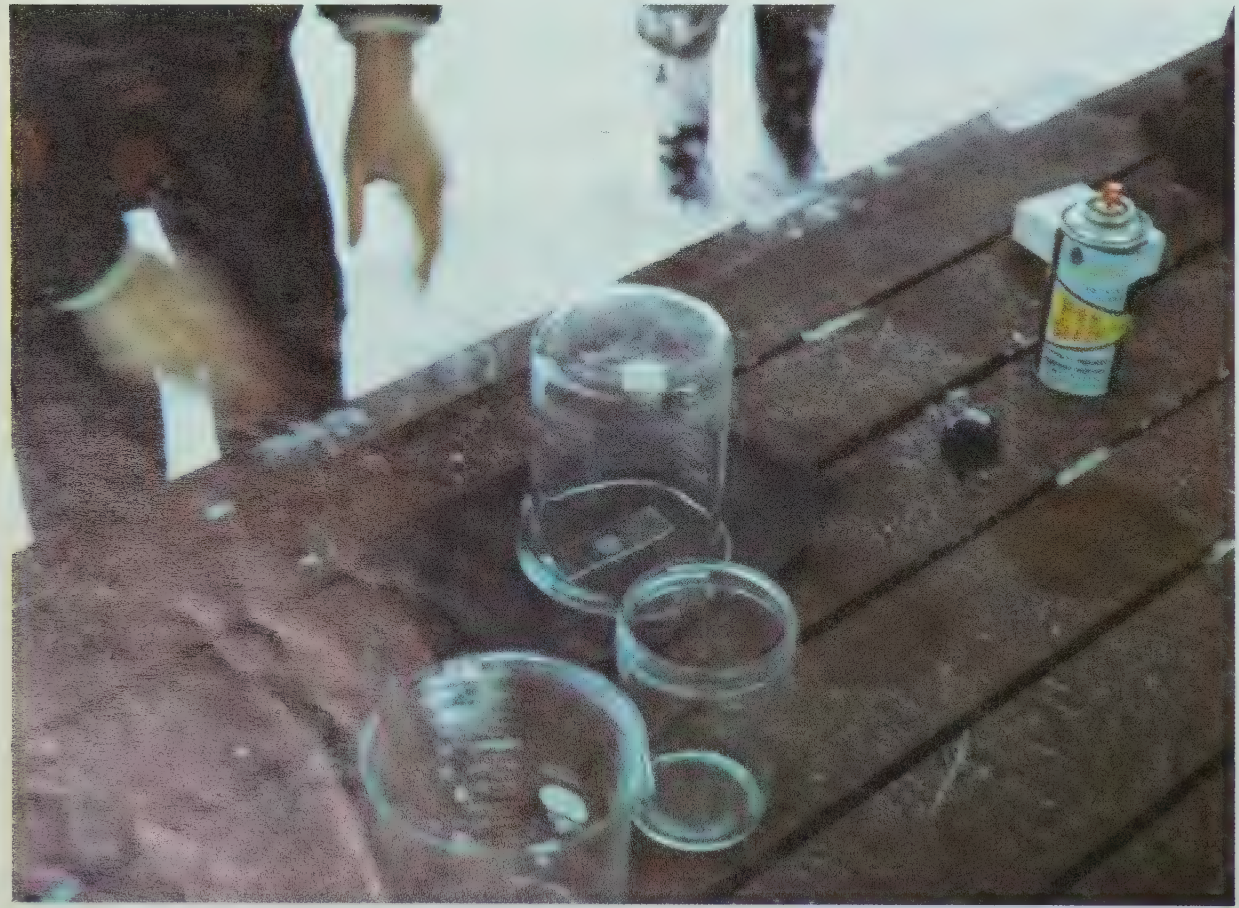
When you have collected some good samples, place the slides in an area sheltered from the falling snow but still outside in the cold.

Allow the lacquer to dry for 2 h.

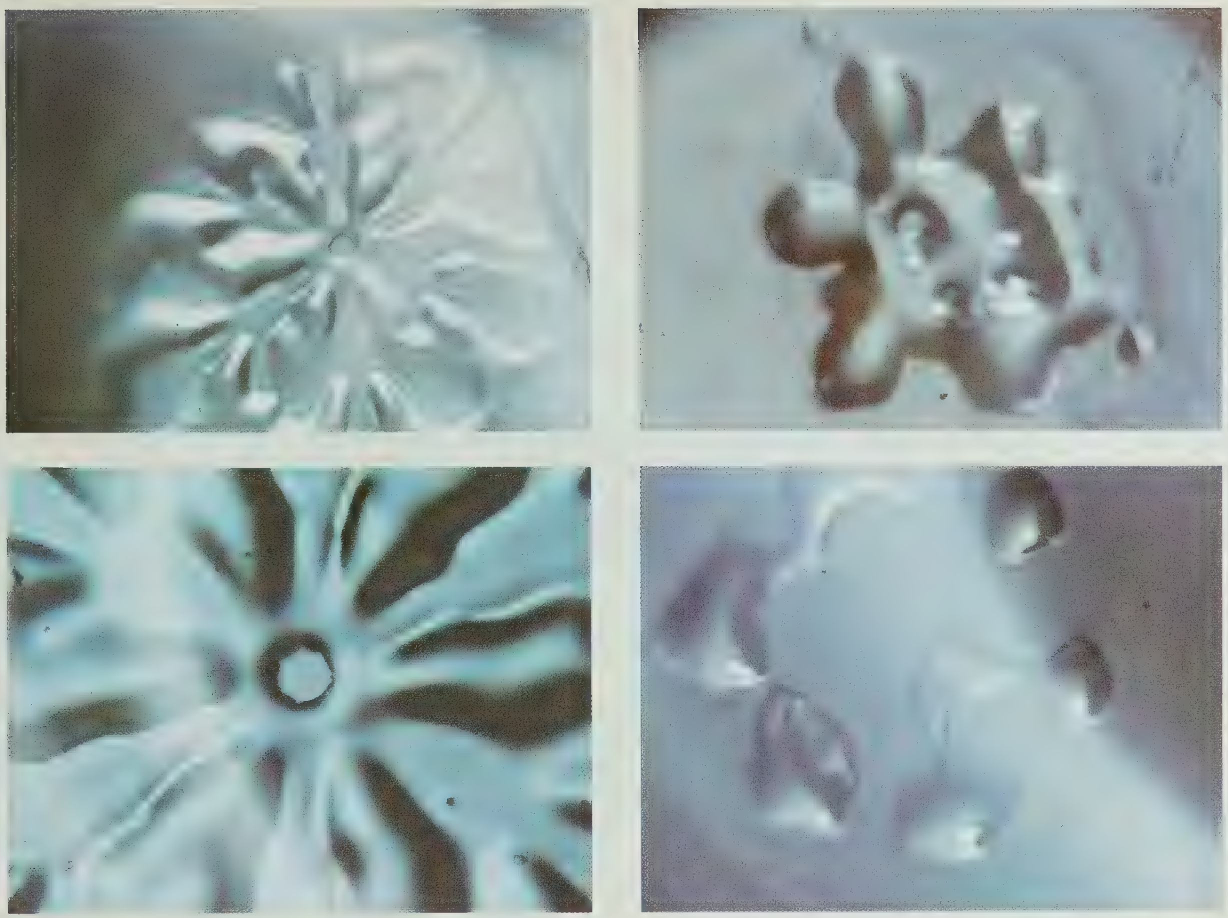
A number of slides should be prepared in the same manner in order to compare several samples of snowflakes.

As the lacquer dries, the snowflakes will leave an imprint. When the drying is complete, after about 2 h, the snowflakes may be allowed to melt.

Do not collect too many snowflakes.



Why should the covered slides be left outside?



Some students preserved these snowflakes. What different types of snow crystals can you find?

When you take the slides indoors, be careful not to touch the lacquer, since it may still be sticky. Study your snowflake prints under a microscope (40 or 50 power).

Find out what the word *symmetry* means. How could you use this word to describe snowflakes?

Why do you think snowflakes are white yet when they melt, they are colourless?

Digging Deeper

Compare your findings with the snowflake chart on page 4 to discover the types of snow crystals that you have found.

Describe the general weather conditions (temperature, wind and moisture) that occurred on the days on which you had your best success with this activity.

Have you collected enough information about snowflakes to agree or disagree with the belief that no two snowflakes are completely alike?

Branching Out

How can the size of snowflakes be measured?

View the graduated side of a ruler under a microscope. How many millimetres is the distance across the field of vision (the whole area that you see through the microscope)?

Use this information to discover the precise diameter of the snowflakes that you have preserved on slides. What diameter is the largest snowflake? the smallest snowflake?

Activity 3:

How can snowfall be measured?

Construct a snow gauge similar to the device illustrated.

Place your snow gauge in an open area before a snowstorm begins. You might read a weather forecast to determine when snow is expected.

Sprinkle some water around the base of the gauge so that it will freeze to the ground and will not be disturbed by wind.

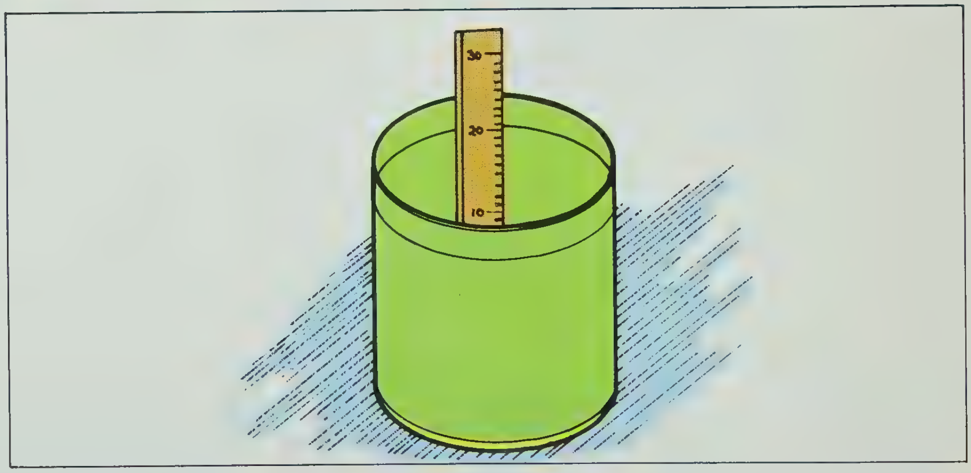
Since you will be leaving your snow gauge outside until the storm is over, possibly for several hours, you should try to find a place where it will not be disturbed by other children.

At the end of the snowfall, return to the snow gauge, and using the scale, read the depth of the snow. Make sure that the snow is level in the snow gauge before you take a reading.

Refer to the following chart for some details that you might record about each snowfall.

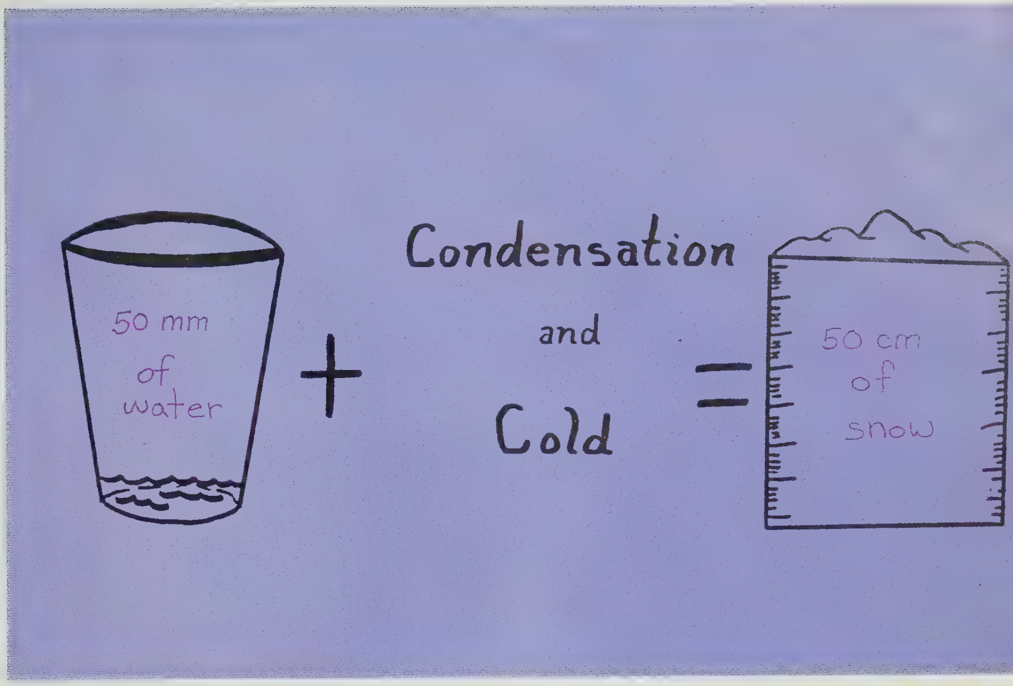
What other information could be recorded?

What care should be taken in taking a reading from the snow gauge?



The Depth of a Snowfall

Date	Location of Snow Gauge	Time of Start of the Snowfall	Time of End of the Snowfall	Snowfall Collected (cm)



Do you agree with this relationship that some students found? Explain your answer.

Digging Deeper

How much snow fell during the storm?

Compare your findings to the amount of snow that the weatherman measured.

At what rate per hour did the snow fall?

If the snow that you collected was allowed to melt, how much water would it equal? Try this melting activity several times to find a relationship between the amount of snow and the corresponding amount of melt water.

Would you believe that:

1. 112.3 cm of snow fell at Kitimat, B.C., to set a Canadian record as the greatest snowfall in a 24 h period?
2. 513.1 cm of snow fell in the Kemano Kildala Pass, B.C. to set a Canadian record for the greatest monthly snowfall.

Write to your local weather bureau to find out the record snowfalls in your area for a day, a month, and a year.

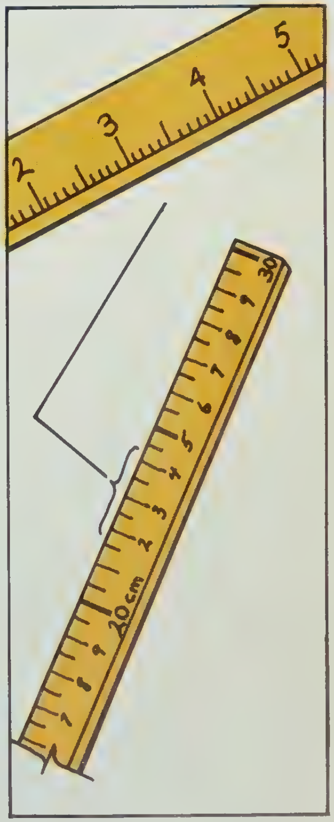
Did you replace your snow gauge so that it would be ready for the next snowfall?

You might wish to measure the snowfall for each month or the whole winter, to compare your findings with the reports from the local weather bureau. If you decide to try this activity, it is most important to find a place where your gauge will not be disturbed, such as a flat roof that can be safely and easily reached.

Branching Out

In what other ways can snowfall be measured?

Another way to measure the depth of snow is by using a device called a snow stick. A snow stick can be made from a broom handle or an old hockey stick. Use your ruler to mark your snow stick in centimetres putting a good strong line at every fifth centimetre. Now you are ready to measure the snowfall in a way similar to the one the weatherman uses.



After a snowfall, go to an open area and insert your snow stick into the newly fallen snow to measure its depth. Care should be taken to make certain that the stick is straight and that only the new snow is measured. When you read the scale on the stick, your eye should be at the same level as the snow.

Make several measurements and average the results.

What are the advantages and disadvantages of this method compared to the snow gauge method?

Activity 4:

What differences in the depth of snow can be found around your school after a snowfall?

To perform this activity you will need either snow gauges or snow sticks.

Make a choice of the device that you will use. This will likely depend on the materials available and the amount of snow that usually falls in your area.

Make several samples of the type of device that you have chosen. Each one should be the same. Follow the instructions in Activity 3 for the construction and use of each device.

You might try measuring the depth of snow in some of the following areas: in the open, under a shrub, under a deciduous tree, under a coniferous tree, in a valley or ditch, on the slopes of a ditch, on top of a building, and along the different sides of a building.

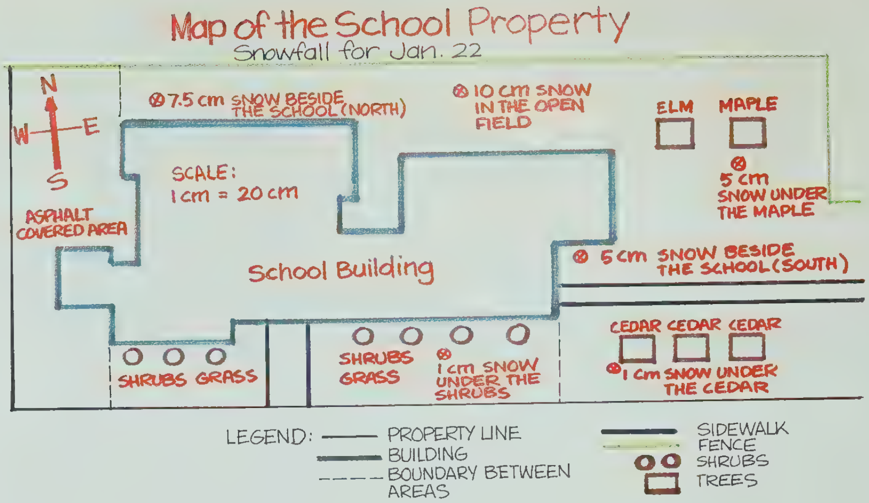
At the end of a snowfall, collect your data by reading and recording the depth of snow collected in the snow gauges or measured by the snow stick.

Display your information on a bar graph.

Digging Deeper

Which area had the greatest snowfall? the least?

What factors might have caused the differences in snowfall for the area that you tested?


Map of the School Property
Snowfall for Jan. 22
N
W
E
S
⊗ 7.5 cm SNOW BESIDE THE SCHOOL (NORTH)
⊗ 10 cm SNOW IN THE OPEN FIELD
ELM
MAPLE
⊗ 5 cm SNOW UNDER THE MAPLE
SCALE: 1 cm = 20 cm
ASPHALT COVERED AREA
School Building
⊗ 5 cm SNOW BESIDE THE SCHOOL (SOUTH)
SHRUBS GRASS
SHRUBS GRASS
⊗ 1 cm SNOW UNDER THE SHRUBS
CEDAR CEDAR CEDAR
⊗ 1 cm SNOW UNDER THE CEDAR
LEGEND:
PROPERTY LINE
BUILDING
BOUNDARY BETWEEN AREAS
SIDEWALK
FENCE
SHRUBS
TREES

Why was it necessary to use the same type of snow gauge or snow stick for each area?

What was the average snowfall for the area that you tested?

How does your average snowfall compare with the snowfall reported by the local weather bureau?

Linus and Lucy decided to measure a snowfall in a different way.

What difficulties might they have?

Why should Linus not discourage Lucy from counting snowflakes even though he has already counted them?

What reasons can you suggest for the differences in snowfall for these areas?

PEANUTS
DON'T TALK TO ME... I'M COUNTING SNOWFLAKES
YOU'RE WASTING YOUR TIME...
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12-10
WHY?
I'VE ALREADY COUNTED THEM!
SCHULZ

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Is it a good idea for Linus to eat snowflakes?

PEANUTS
CATCH THE SNOWFLAKES ON YOUR TONGUE, LUCY!
IT'S TOO EARLY... I NEVER EAT JANUARY SNOWFLAKES... I ALWAYS WAIT UNTIL FEBRUARY...
1-5
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SCHULZ
THEY SURE LOOK RIPE TO ME!

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Activity 5:

How clean is snow?

Place a clean container, such as a glass, dish, or saucer in an open area during a snowfall. When the container is full, take it indoors. Cover the top so that no dust settles in the container, and let the snow melt.

Obtain a clean piece of filter paper or paper towelling and examine it carefully for any specks.

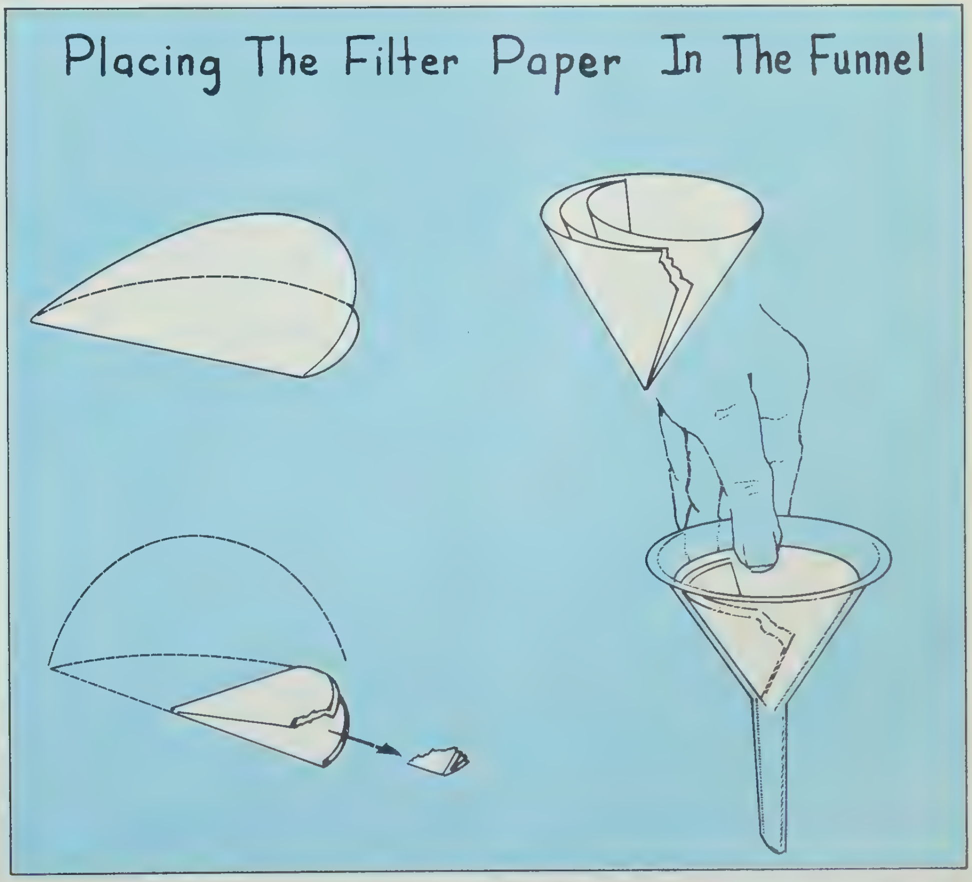
Place the paper in a funnel.

Pour the melt water from the snow into the funnel so that the water will pass through the filter paper and into the collecting jar. Save some of the melt water to be later compared to the filtered water.

Examine the filter paper carefully with a hand lens.

Compare the melt water with the filtered water. You might place a few drops of each type of water on clean slides and observe them under a microscope.

Why was it important to examine the filter paper before pouring the melt water through it?



Digging Deeper

What can be seen on the filter paper?

What differences can you see between the melt water and the filtered water?

What do you think was the origin of any new material on the filter paper?

Can you study the filter paper under a microscope to obtain more detail about the material?

What would you see if you magnified a melted snowflake?

What resources could you use to learn more about this material?

What is your answer to the question beside the cartoon on page 13?

Activity 6:

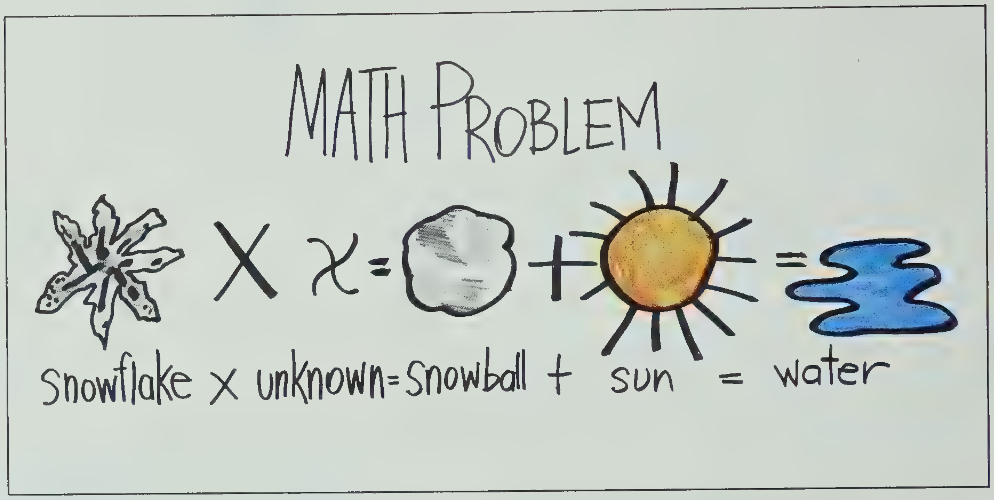
Can you solve a snow math problem?

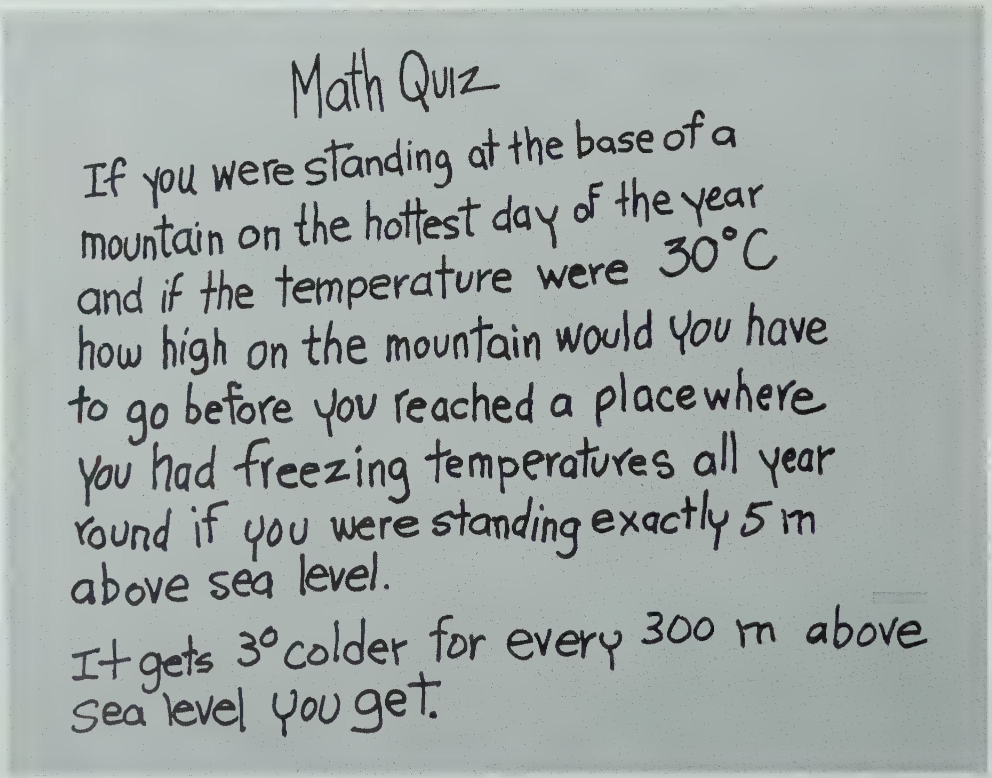
The following snow math problems were made by a group of students after they had performed activities with snow similar to the activities in this chapter.

What is the unknown in the open number sentence in the top diagram?

Try to devise a series of snow math problems that you could use to test your classmates.

The bottom diagram is a question from a student's notebook. Can you solve the math quiz problem?


MATH PROBLEM
X
x =
+
=
Snowflake x unknown = Snowball + sun = water


Math Quiz

If you were standing at the base of a mountain on the hottest day of the year and if the temperature were 30°C how high on the mountain would you have to go before you reached a place where you had freezing temperatures all year round if you were standing exactly 5 m above sea level.

It gets 3° colder for every 300 m above sea level you get.

Snow All Around

2

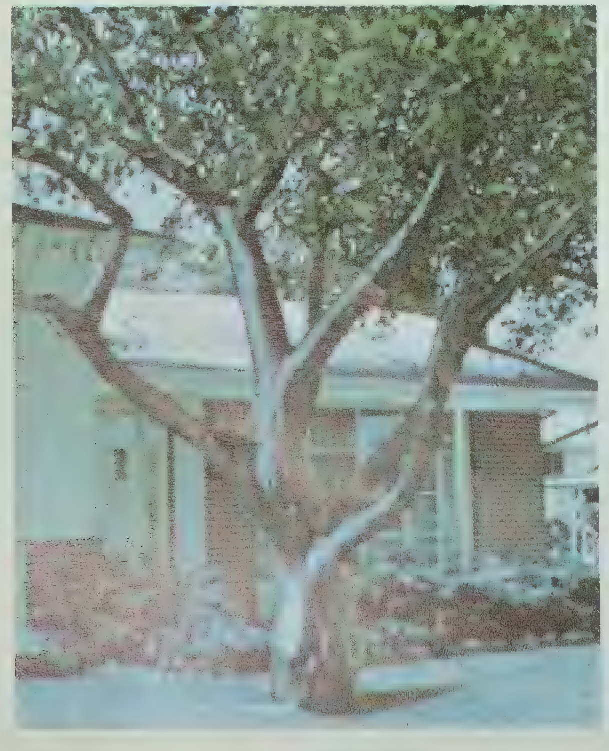
2. Snow All Around

Have you ever awakened and looked out of your bedroom window onto a pure white blanket of freshly fallen snow? You were probably very anxious to eat your breakfast and get dressed in your winter outfit, especially if it was the season's first real snowfall. Possibly, you called on your friends to play and enjoy the winter scene.

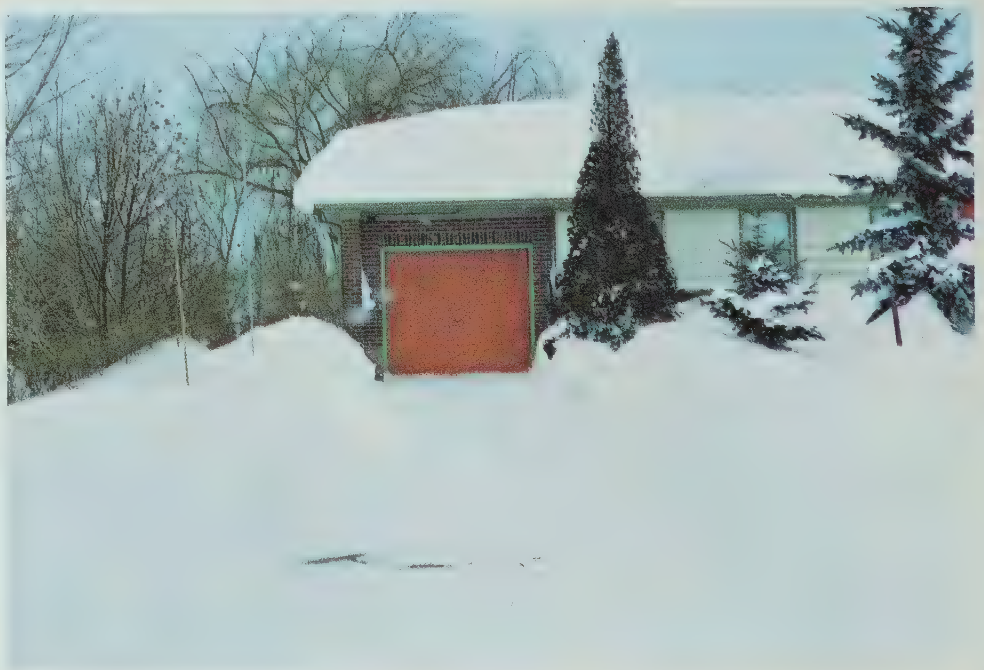
Sometimes, however, snow not only provides us with a new playground, but it also requires us to do some hard work.

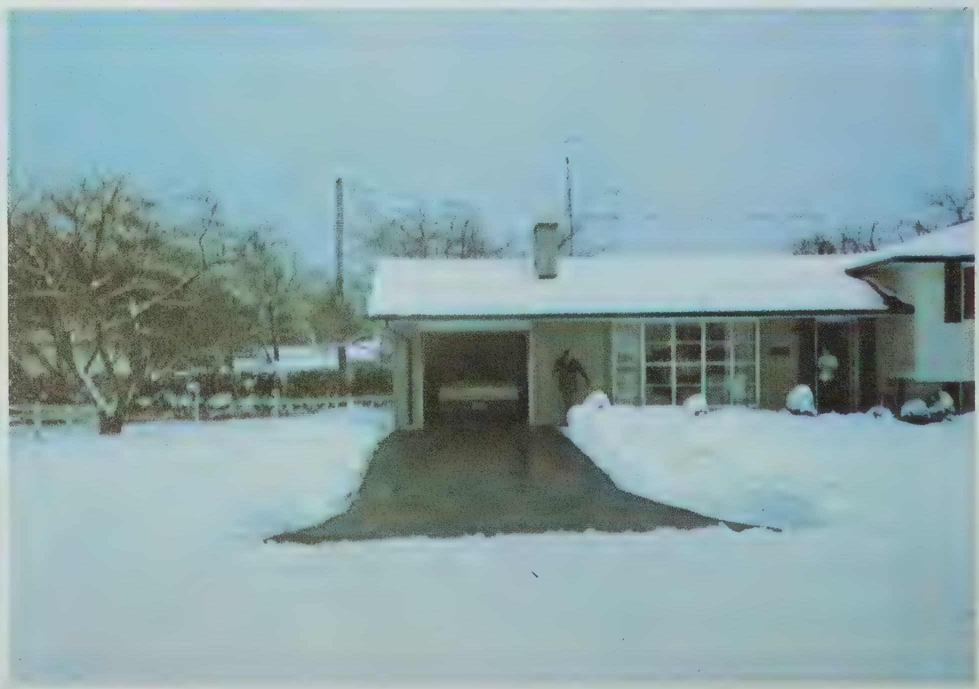
Perhaps you noticed new and interesting *snow magic* while you were playing or doing your chores. The following photographs illustrate some familiar winter sights.

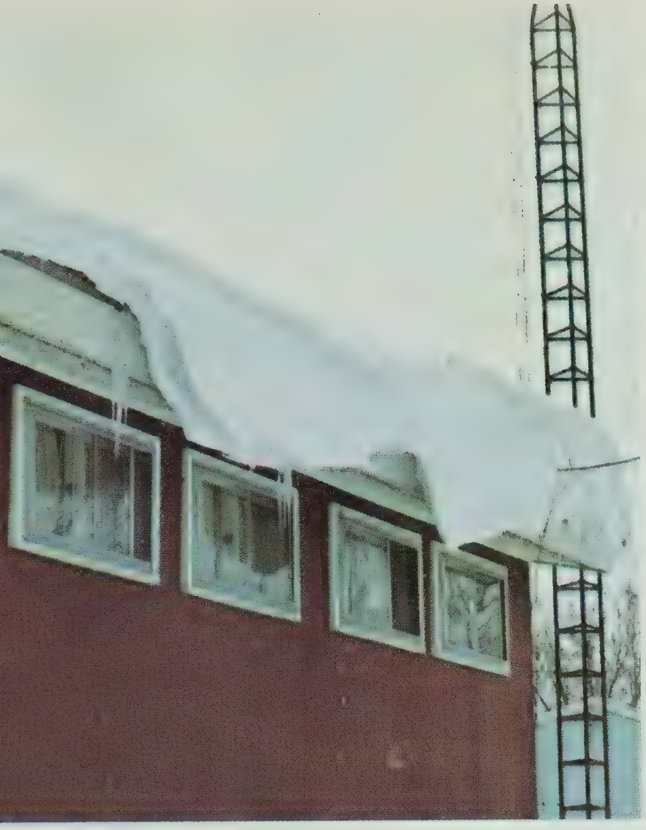
Why is there snow on the same side of the large branches and trunk of this tree?



Which driveway was cleared with a shovel and which one with a snow blower? Why?

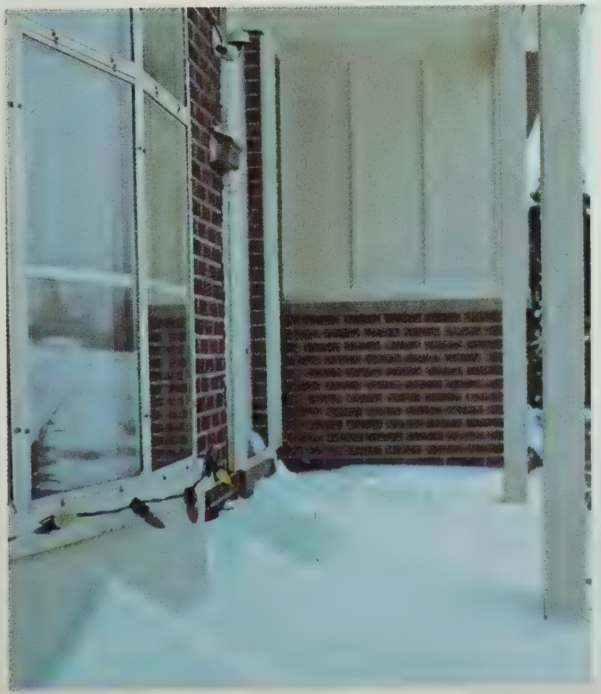


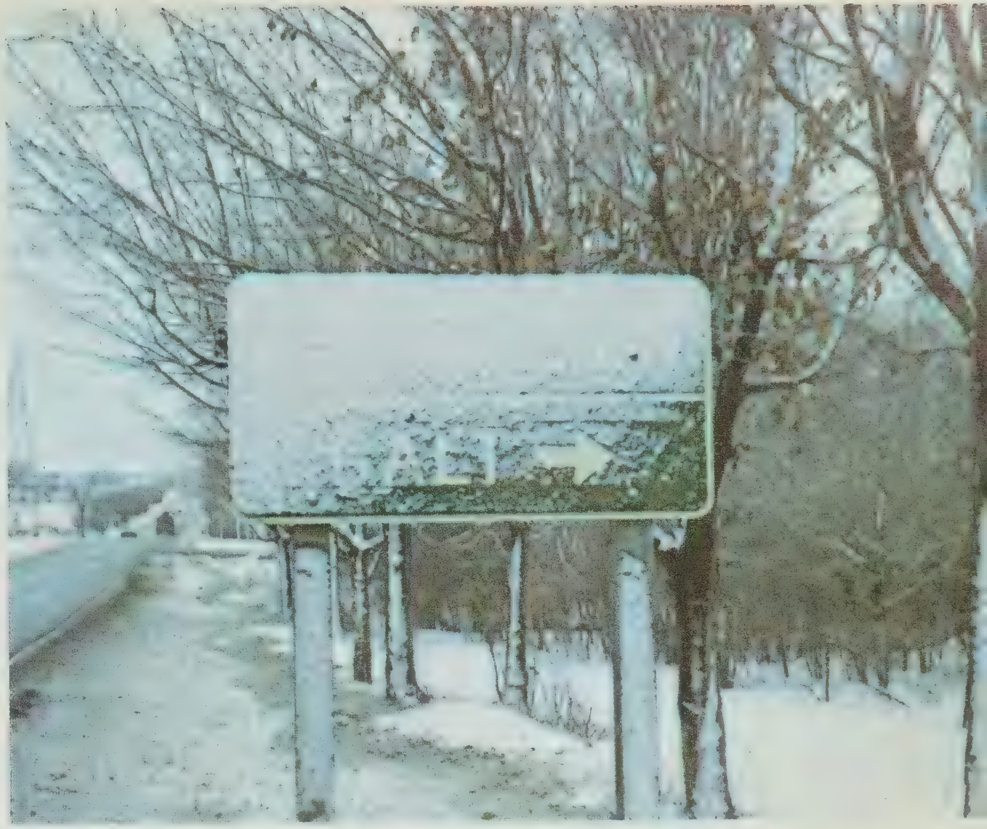




What has caused the interesting overhang of snow on the roof?

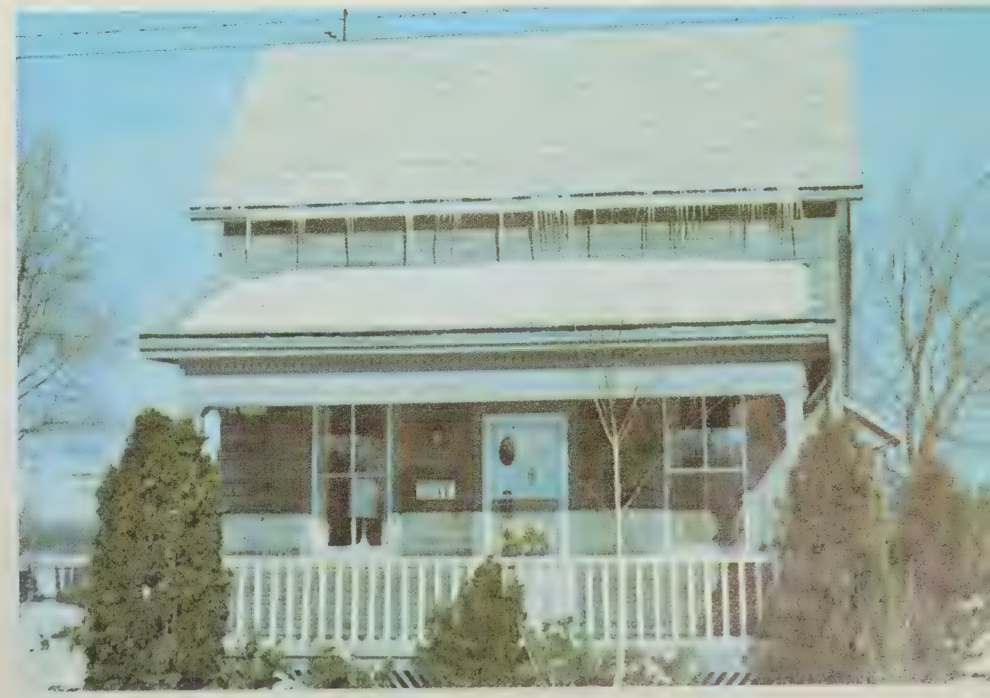
In which direction was the wind blowing in this photo?





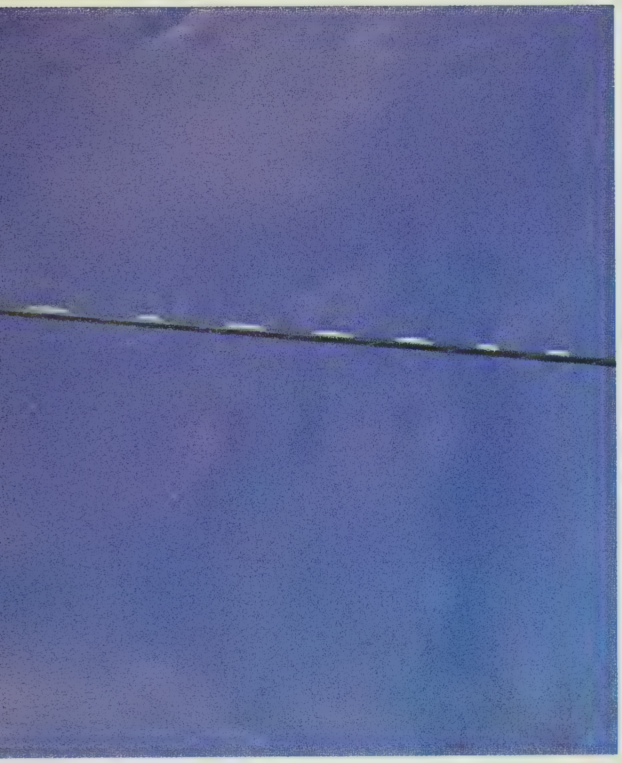
Why does the snow not completely cover the sign?

Is the roof of this house insulated? Explain your answer.



What effect does snow have on the branches of trees?

How would you explain the unusual snow pattern on the hydro wire?



On a pleasant day after a snowstorm, take a winter wonder walk around your home or school. Can you add to the list of snow scenes that are shown in the above photographs? Use your five senses to help you describe the interesting things that you observe. Record your observations so that you can discuss some of your snow mysteries in class. One student decided to write a poem about her experiences.

The activities in this chapter have been designed to help you investigate some of the mysteries that may have aroused your curiosity. If you discovered something that is not described in this book, don't be timid! Try to design your own activity that will help you to learn more about your interest.

Happiness is Snow!

I wake up in the morning
And what do I see:
A beautiful snow has covered
my tree.
With my sleigh I am rushing
And flying downhill,
Thanks to the snow, there is
happiness still.

Lucy Albanese

Activity 1:

What conditions are right for packing snow?

Go outside on several different days and make snowballs: when the air temperature is about 0°C, when the air temperature is about —10°C, when the snow temperature is about 0°C, when the snow temperature is about —10°C, with new snow and old snow, with loose fluffy snow and very compact snow.

Describe how the snow packs each time that you make snowballs for this activity.

Digging Deeper

What conditions are right for packing snow?

What names could you give to other types of snow?

How could you make nonpacking snow into packing snow?

Glistening Snow

Did you notice on your winter walk how brilliant snow is? Most people adjust their eyes by squinting or using sunglasses when they are outside on a sunny day in the winter. Some people, such as Eskimos, who live in the far north use snow glasses to protect their eyes from the glistening snow.

On a sunny day when the ground is covered with snow go outdoors with a friend. After your eyes have adjusted to the brightness look at the size of the pupil in your friend's eye. Sketch the eye showing the size of the pupil. Go indoors and try the same activity. What reasons can you give for the difference in pupil size? Why is it difficult to see for a few minutes after you come indoors on a bright day? What is snow-blindness?

Snow often appears to send flashes of colour toward us but when viewed from other angles it looks white. This light is reflected off the snow, from the sun to our eyes. The amount of light can be measured with a light meter. You might be able to borrow a light meter from someone whose hobby is photography.

How will the home-made snow glasses help Joe's eyesight on a bright day?

Activity 2:

What differences in snow brightness can be found around your school?

A light meter is a delicate and expensive instrument that should be handled with care.

Make a scale from 0 to 10 on a piece of Bristol board that can be attached above the window on the meter so that the lowest light reading will be on the left side and the highest on the right side. Your scale will be read in units of light. You can make up a name for these units.

Attach the light meter to a ruler with masking tape so that the part where light enters the meter is at the 10 cm mark and is pointing downward.

When you use the meter, be careful not to point it at very bright objects, like the sun. Instead, point it at the surface from which you are measuring the reflection of sunlight.

On a sunny day test the following areas around your school; snow in the open, snow in the shade, an icy sidewalk, clean snow, dirty snow, loose snow, very compact snow, snow on both sides of a ditch, slushy snow.

Point the light meter at each surface from a height of 10 cm.

Record your information on a chart or graph.

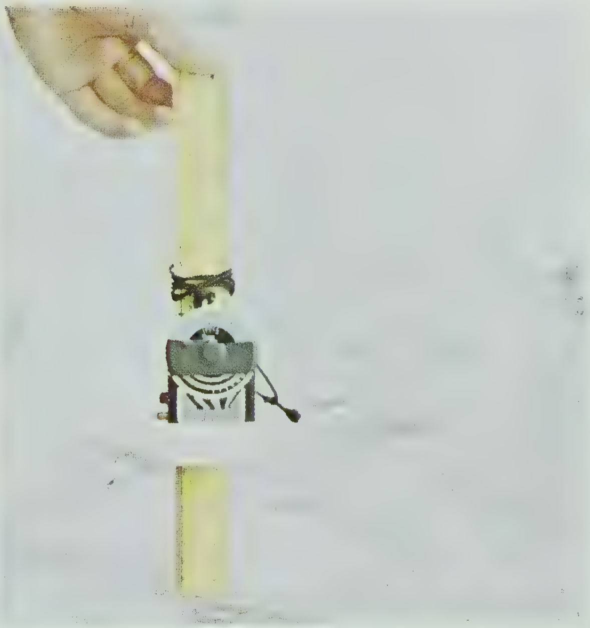
Digging Deeper

Which area reflected the most light? the least light?

In which area that you tested will the snow probably melt first?

What effect does the reflection of light have on the melting of snow in an area?

How is the human eye adapted for protection against bright sunlight and snowglare? To help you find a good answer you might borrow a reference book on the human eye from your local library or ask your doctor.



Where does the light enter the meter?

Which area is reflecting the most light?

Drifting Snow

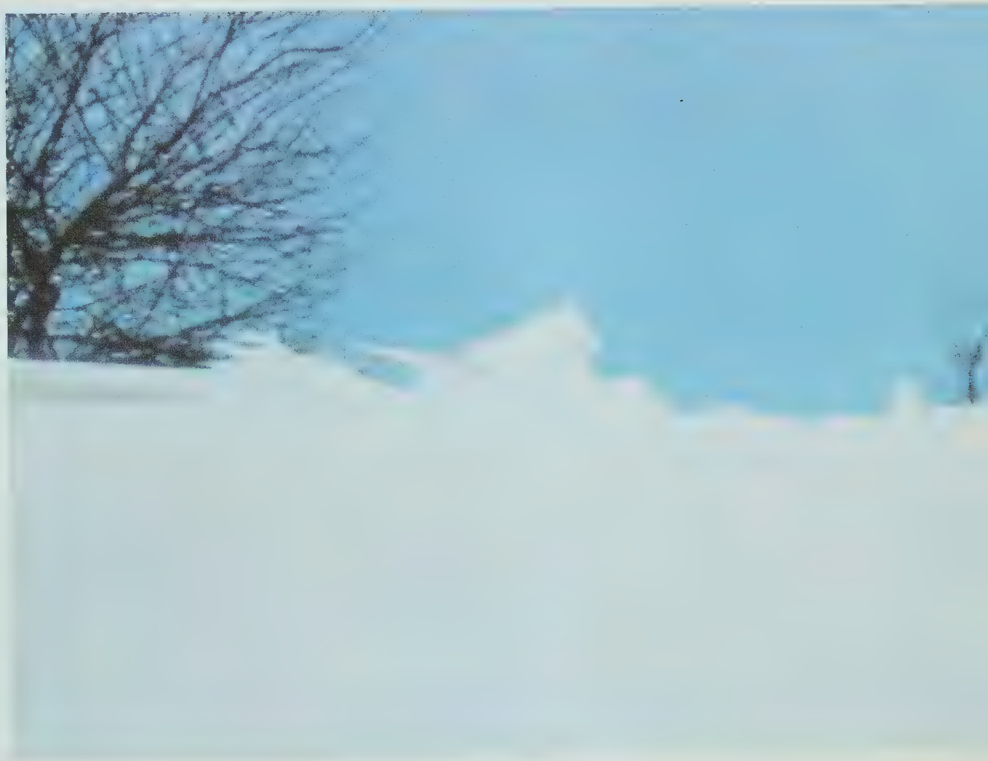
Perhaps you noticed the unusual ways in which snow has been deposited around your school.

Activity 3:

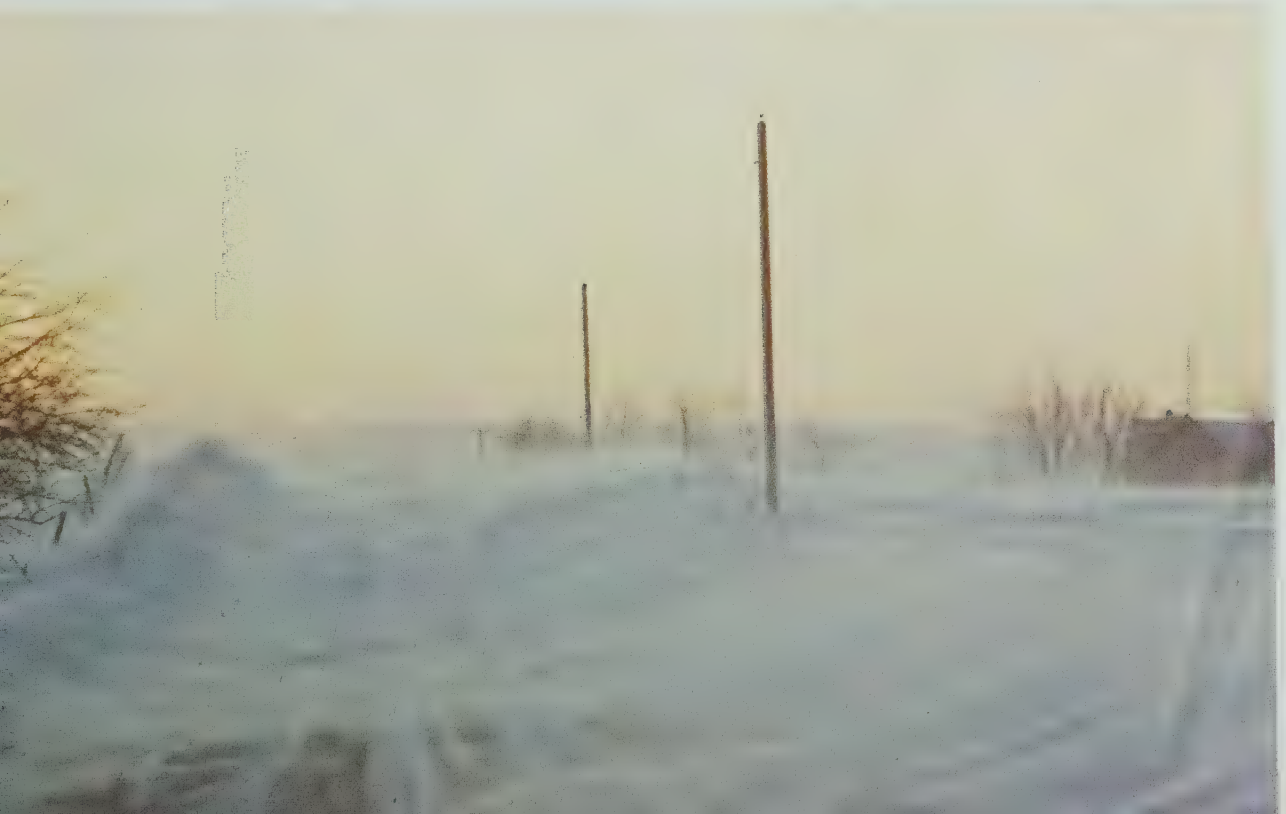
How does a snowdrift form?

Find an open area around your school where there are no drifts or banks of snow. This area will be a good place for you to set up an experiment to form your own snowdrifts. Try to choose an area that will not be disturbed by other students. Investigate this activity on a day when drifting snow is forecast by the local weather bureau.

Find the direction from which the wind usually blows.



How does the activity of snow in the photograph at the bottom help to explain the mysterious shapes in the top photograph?



Cut three pieces of plywood or sturdy cardboard, 1 m long and 50 cm wide.

Insert one into the snow lengthwise so that the prevailing wind is blowing directly at the face of the board. Support the board with rocks or bricks on each side so that it cannot be blown over.

Place the second board so that the prevailing wind is blowing against one of its edges.

The third board should be placed at an angle to the prevailing wind.

Why should the three boards be placed abreast of each other and not in line with the prevailing wind?

Record the depth of snow on both the windward (the side from which the wind is blowing) and leeward (the protected side) of each board.

Return to your area the next day or after considerable drifting has occurred.

Measure the snow depths on the windward and leeward sides of each board again.

Record your information to show what has happened before and after you allowed drifting to take place around each board.

Digging Deeper

Around which boards did drifting occur?

Around which board did the most drifting occur?

How could these students support the boards?

From what direction should the prevailing wind blow in this photograph?

These students are measuring the height of a fence near a deep snowdrift to see if there is a relationship.

On which side of the boards did the most drifting occur?

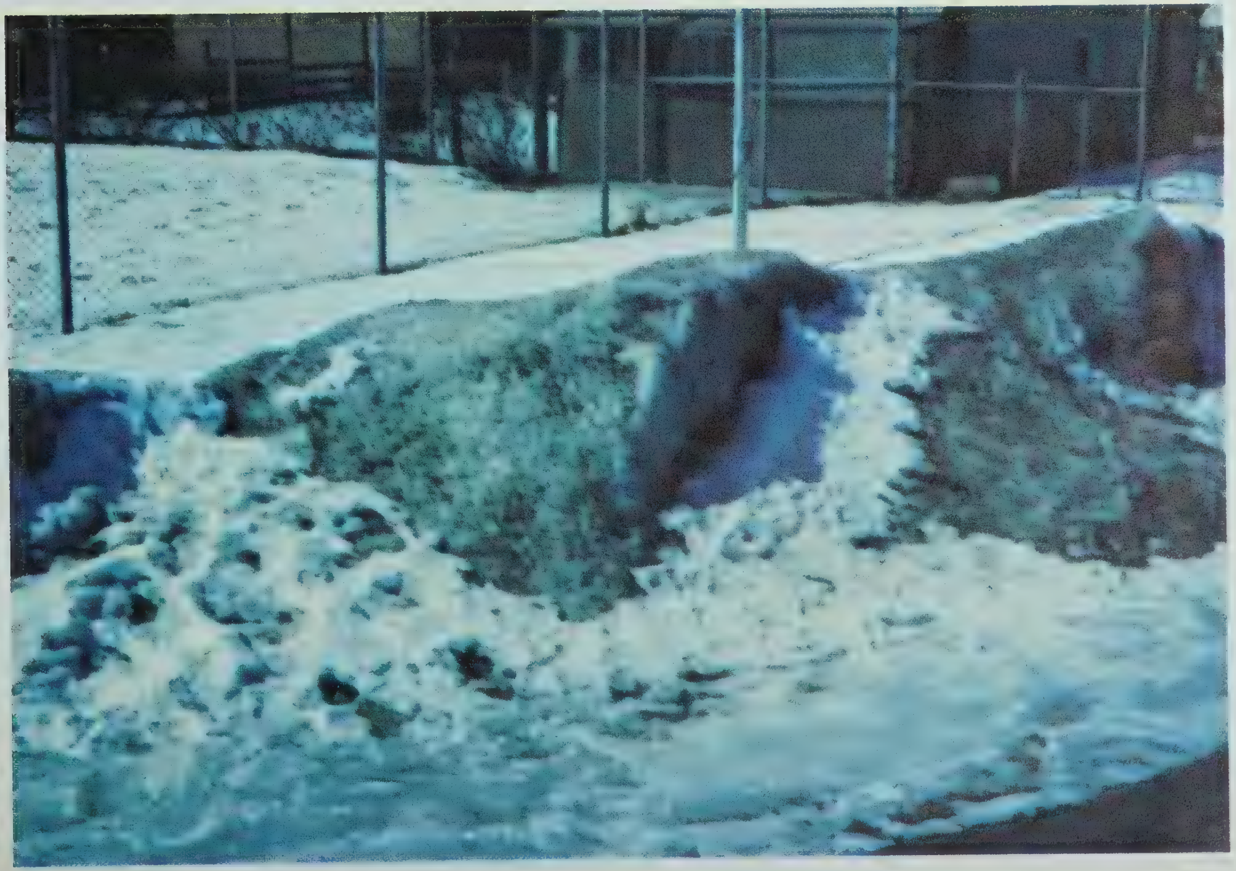
Was there any drifting on the windward side of each board?

What distance was there from the board to the beginning of the snowdrift in each case?

What would happen to the distance from the board to each snowdrift if a higher or lower board was used?

What time interval did you use between measuring the before and after results of your experiment?

What would happen to the snowdrifts if you continued the experiment for the same period again?



How was the snowbank on the school grounds in the photograph formed?

Branching Out

What causes a snowdrift?

Repeat Activity 3 on a windy winter day with obvious snowdrifting.

Instead of leaving the experiment for a period of time to allow the snow to drift around the boards, measure the wind speed around the boards during the windy conditions.

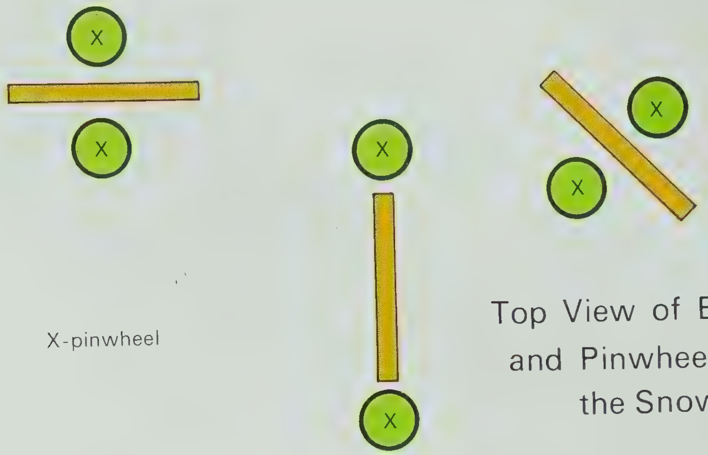
To measure wind speed obtain six similar pinwheels. Adjust the pinwheels so that they rotate at about the same speed in a breeze. Place them in the snow on both the windward and leeward sides of each board so that the spinning device of each pinwheel is the same height above the surface of snow (at least 15 cm) and the same distance from each board (15 cm). Be certain that all the pinwheels are facing the wind.

Make a diagram of the position of the boards and the pinwheels.

Observe the pinwheels for 15 min and list suitable words to describe how fast the wind is causing them to spin. Your list of words might include: extremely fast, fast, fairly fast, slow, very slow, not moving. On the diagram label each pinwheel with the words that best describe the speed at which it is spinning.

From the data gathered from this activity and the other activities dealing with drifting snow explain what happens to the wind as it approaches and blows over an object.

You have probably discovered some causes of snowdrifting. Activity 4 will guide you in examining snowdrifts that are formed around snow fences. Snow fences can be frequently found beside the highways in rural areas. You might take a field trip to an area where there are snow fences that are easily reached. Are there snow fences near your school? You should speak to the owner of the property on which the snow fence is located and ask permission to use it for your project.



Top View of Boards and Pinwheels in the Snow

On which side of this board will the wind be stronger? Where will a snowdrift form?

Activity 4:

How can snowdrifts be studied around a snow fence?

Select an area where snow has obviously drifted on one side of a snow fence.

It would be best to perform this activity with a large number of students on a very cold but sunny day.

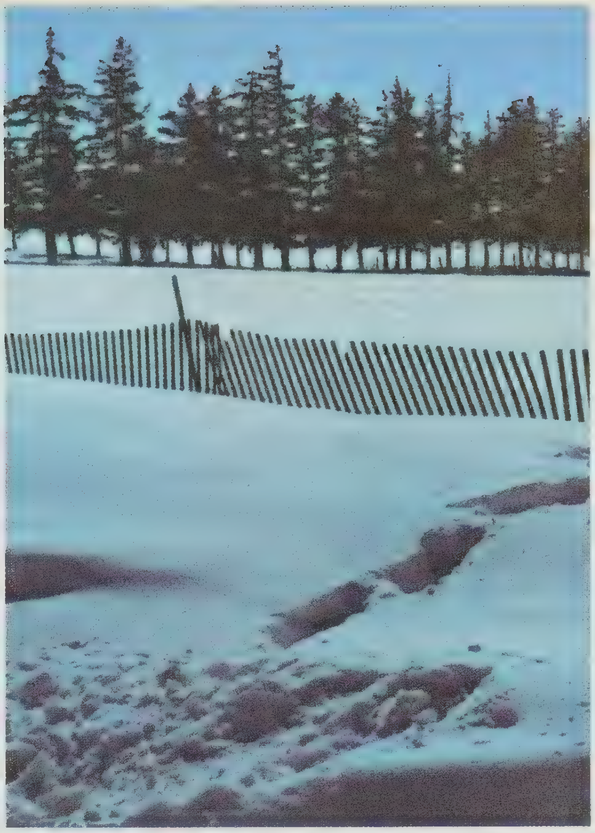
In order to obtain a clear overall picture of a snowdrift, it is advisable that the same steps be carried out at a number of points or stations along the length of the drift. Many students can participate with two or three at each station.

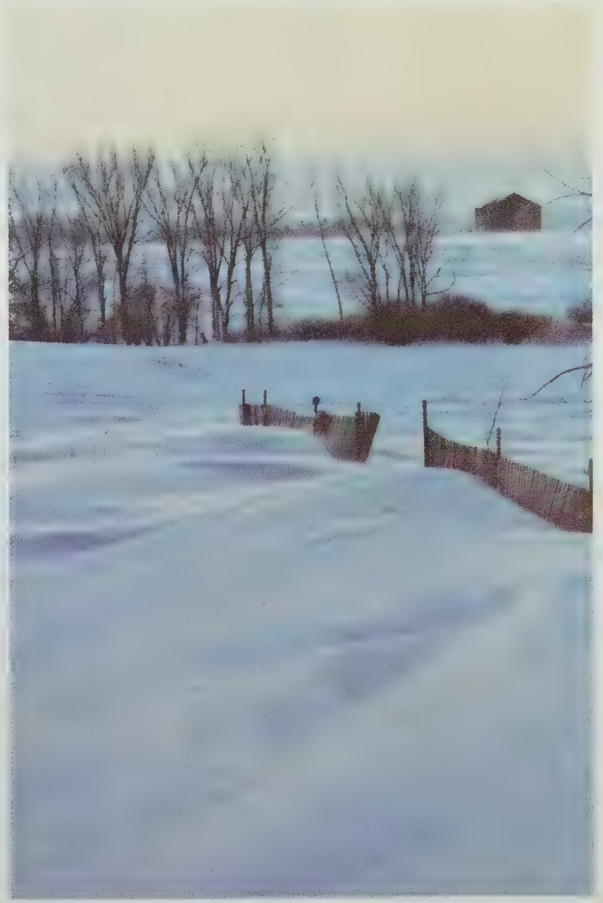
Establish study stations along the length of the snow fence and number each one starting at one end of the fence. The distance between each station could be 25 m. If the snow fence extends for a short length, you could decrease the distance between each station accordingly.

At each station dig out a cross section of the drift in which a student can easily move about. The sides of the cross section should be as nearly vertical as possible.

Perform the following activities at each station:

(a) Take the temperature of the snow at 20 cm intervals from the bottom of the cross section to the top. Insert the thermometer horizontally, 20 cm into the snowdrift. When the liquid in the thermometer has stopped moving read the temperature, being careful to move the thermometer as little as possible.



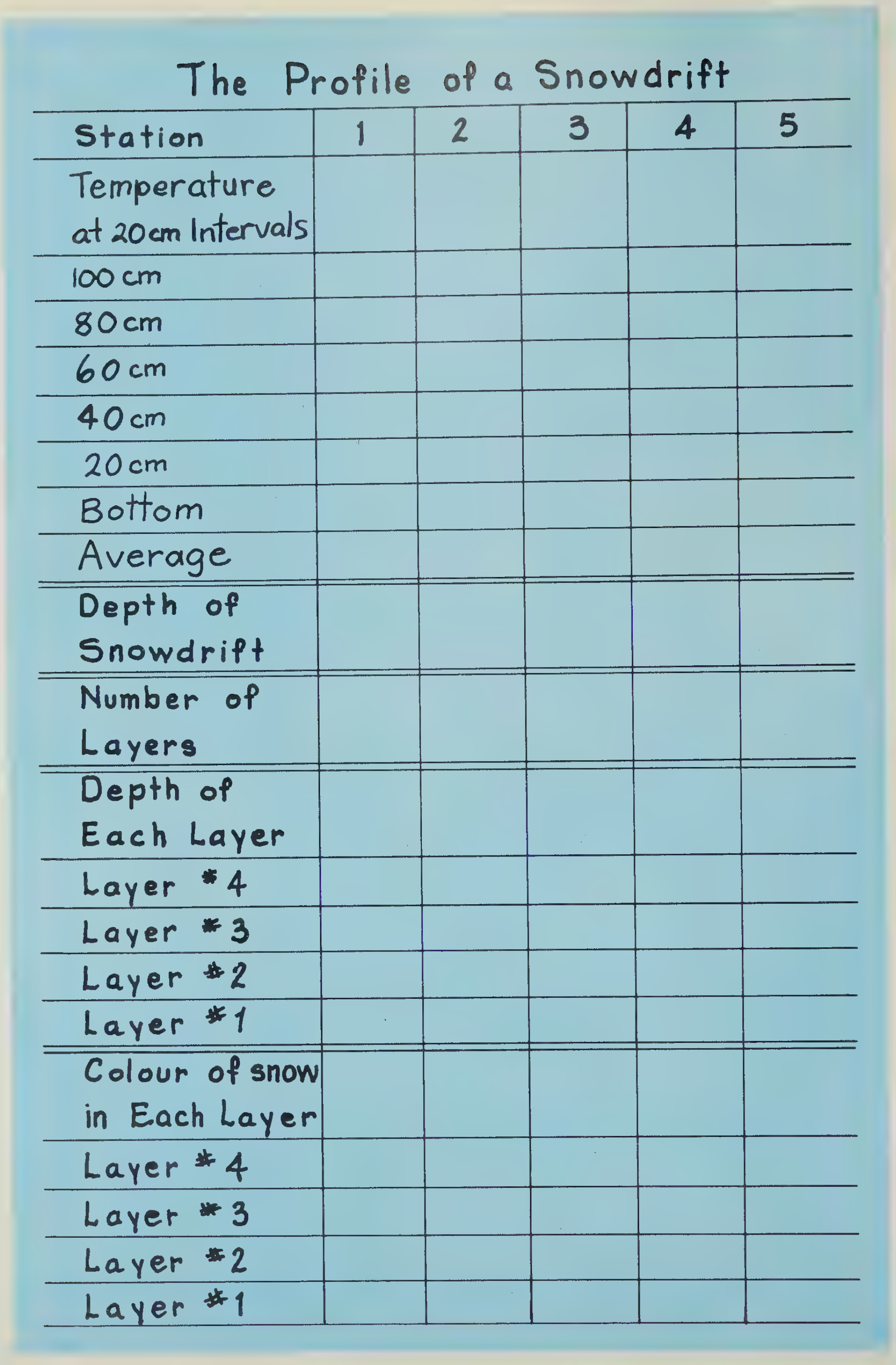


In each photograph, where should the nearby highway be located?

(b) Measure the depth of the snowdrift in the middle of the cross section.
(c) Count the number of layers of snow in the cross section.
(d) Measure the depth of each layer of snow in the cross section, starting at the bottom.
(e) Describe the colour of the snow in each layer.
(f) Make a sketch of the cross section of the snowdrift, showing as many features as you can.

When all of the stations have completed their activities, transfer your field notes to a record sheet (like the one illustrated) for the whole snowdrift.

You might want to record the data for your station on the cross section diagram of the snowdrift. If all of the students made their records in this way they could place the diagrams on a blackboard in the order of the stations. If you are artistic, you might draw the snowdrift and snow fence on the blackboard as a suitable background.



The Profile of a Snowdrift

Station	1	2	3	4	5
Temperature at 20 cm Intervals					
100 cm					
80 cm					
60 cm					
40 cm					
20 cm					
Bottom					
Average					
Depth of Snowdrift					
Number of Layers					
Depth of Each Layer					
Layer #4					
Layer #3					
Layer #2					
Layer #1					
Colour of snow in Each Layer					
Layer #4					
Layer #3					
Layer #2					
Layer #1					

Digging Deeper

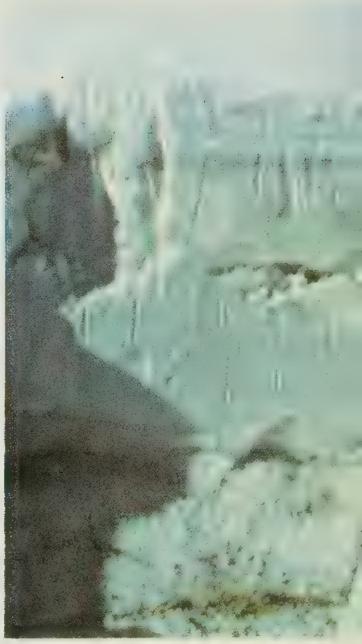
Plot the temperature readings from your cross section on a graph. Join the temperature points on your graph with a line. Describe the shape of the line or curve. Compare your curve with the line graphs that were made by the students at other stations. How are the curves the same? different?

What is the warmest part of the snowdrift? the coldest?

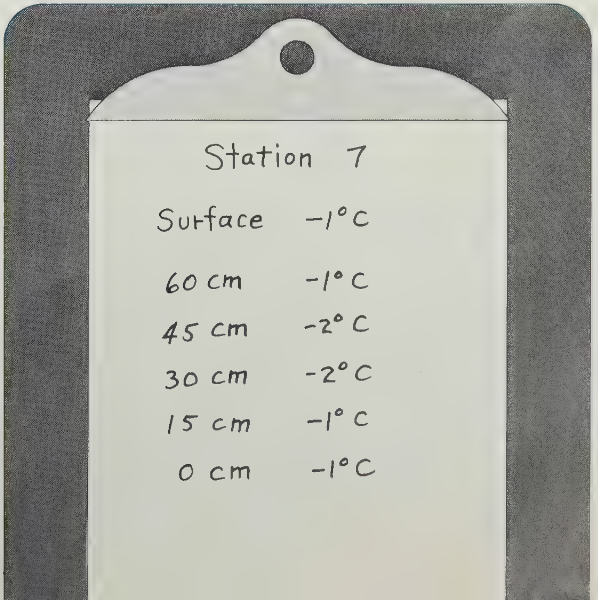
Is snow a good *insulator?*
What caused the layers in the snowdrift?

How can you explain the colour differences in the layers of snow?

What would be the best number of students to have at each station?



How many layers of snow can you count in this cross section?

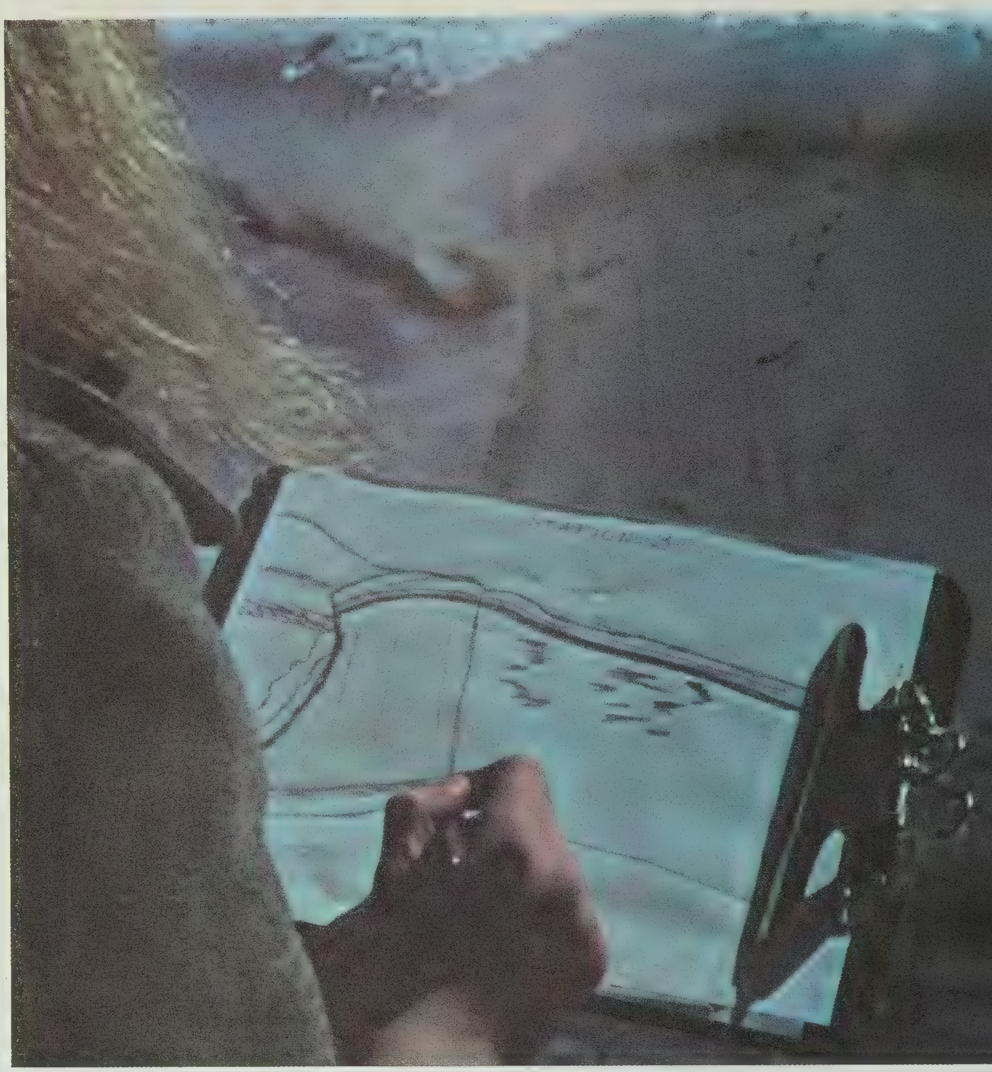


Station 7

Surface	-1°C
60 cm	-1°C
45 cm	-2°C
30 cm	-2°C
15 cm	-1°C
0 cm	-1°C

What evidence have these boys collected to demonstrate that snow is an insulator?

Try to sketch your cross section of the snowdrift.



Are the bottom layers of snow in your cross section more compact than the top layers? Try to devise an experiment to demonstrate which layer of snow is most compact.

You might have noticed a certain overhang of snow on the side of the snowdrift opposite to the snow fence. Refer to the photograph of snowdrifts above. The overhang or shelf of snow is called a *cornice*. Can you account for its cause?

What is the purpose of a snow fence?

You might use the following questions as a guide to help you interview the owner of the property on which the snow fence is located, so that you will have a better understanding of snow fences.

How far from the highway or road was the snow fence placed?

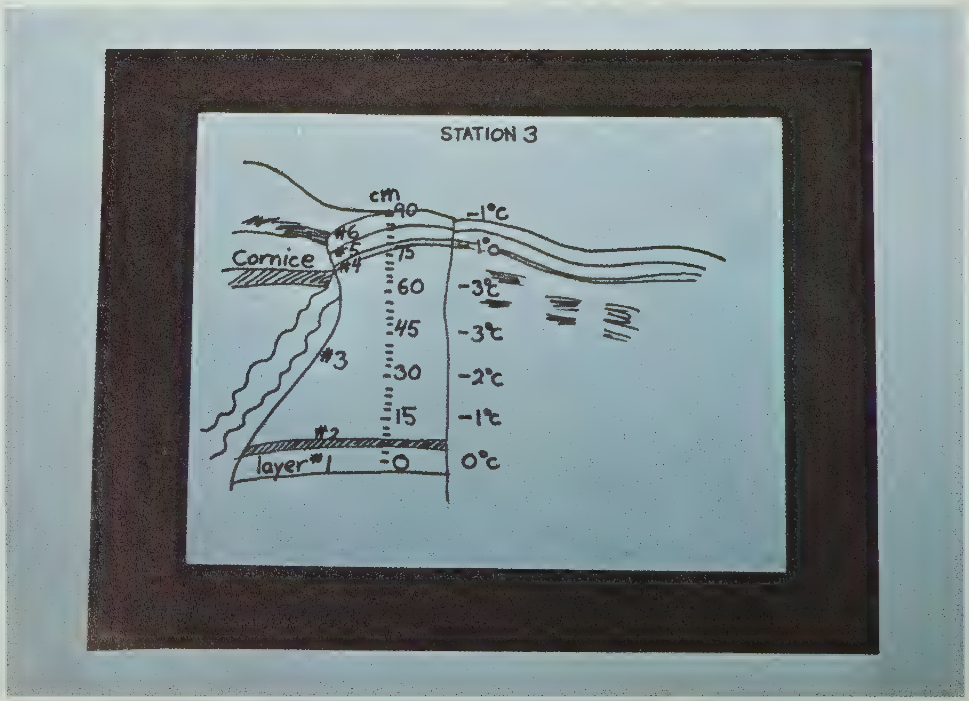
Is this distance the same for other snow fences along the same highway?

On which side of the highway or road was the snow fence placed? Are other snow fences along this highway placed on the same side?

How would the people who erected the snow fences know exactly on which side and what distance from the highway to place the snow fences?

Who is responsible for erecting snow fences along highways and roads?

When are snow fences in your area erected?



What information can you display on your sketch?

What happens to the snow fences during the summer months?

Would snow fences work better if they were solid rather than slatted?

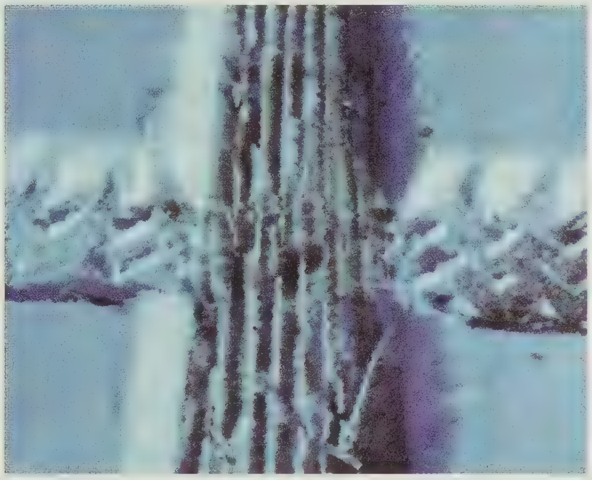
Snow Tracks

Activity 5:

What interesting types of vehicle tracks can you find around your school?

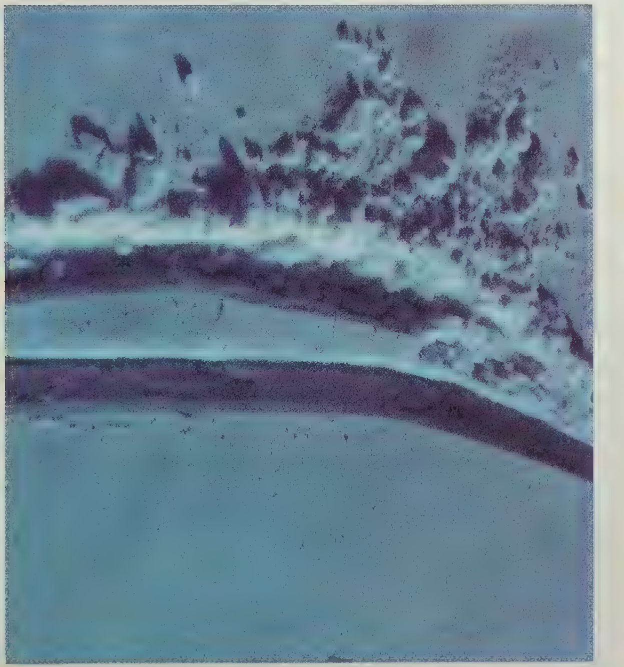
The following photographs illustrate interesting tracks made by different vehicles.

Try to answer the questions by carefully observing the tracks in each photograph.

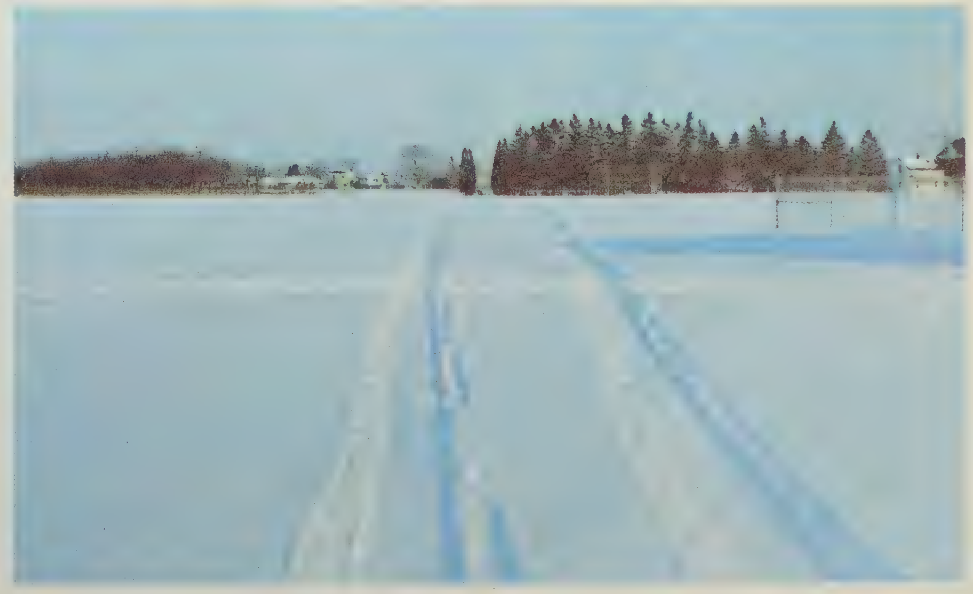


Which track was made first? Why?

Which track was made by the front wheel of the bicycle? Why?



What type of vehicle made these tracks?



Take a walk around your neighbourhood to find interesting tracks made by vehicles such as bicycles, cars, trucks, buses, snowmobiles, skis, etc.

Draw sketches or take photographs of interesting tracks that you find. Display these on a bulletin board and pose questions under each one for your classmates to answer.

Use your imagination to stage some of the scenes. For instance, you could add humour to your display by staging a photograph in which two ski tracks are shown, one on each side of a tree trunk. What caption or question could you attach to such a photograph?

You can try to take a double exposure in which you photograph two scenes on the same exposure or frame number.

Digging Deeper

How does the depth of tread on a tire compare to the height of the tread mark in the snow track?

Does a fast moving vehicle make a better track than a slow moving vehicle?

What type of snow is best for finding good tracks?

How many tracks did you find that would indicate that the vehicle that made them should have new tires?

Refer to page 34 to guide you in preserving your favourite tracks by making plaster casts.

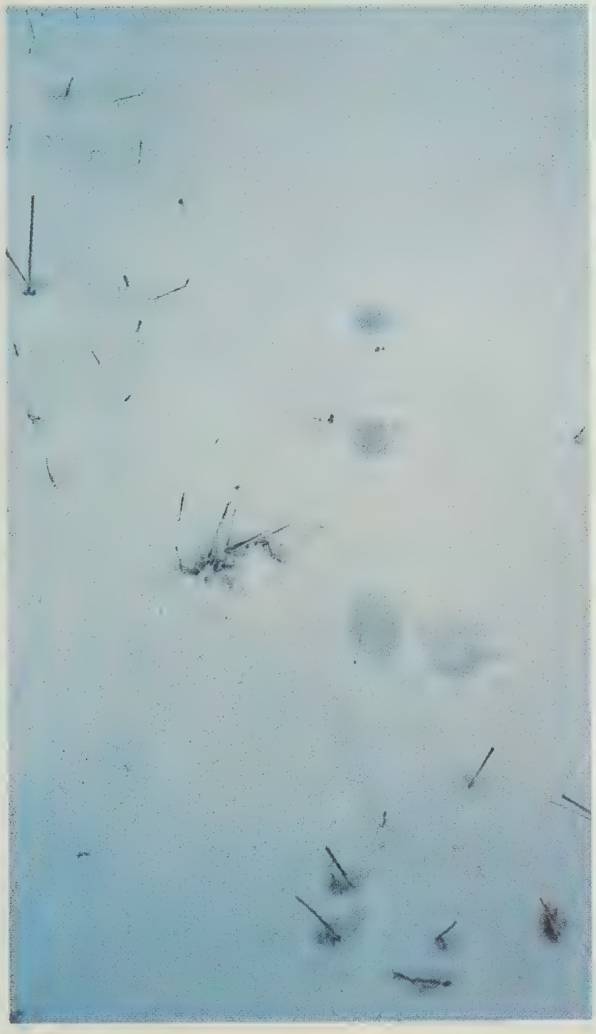
Tracking Animals

Evidence of the presence of animals is easy to discover in the winter because of the tracks that are left in the snow. In order to find the tracks of wild animals you will need to visit their *habitats.* Woodlots, meadows or marshy areas in the country are the best places to start your hunt. In the city, a search of parklands, golf courses, fields, and wooded areas, as well as bird feeding stations will also produce different types of wild animal tracks. Domestic animal tracks are most readily found in backyards, school grounds, lawns and along sidewalks.

The following photographs demonstrate tracks made by living things.

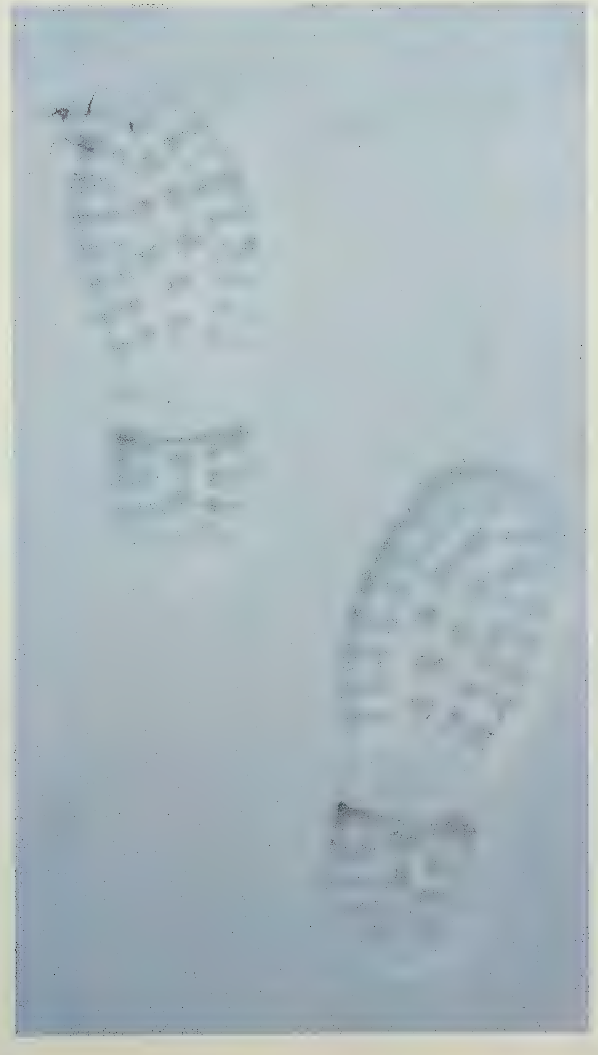
Why does a snow tire give better traction in the snow than a regular tire?

Why is this track raised above the ground rather than depressed into the snow?



In which direction was the animal that made these tracks travelling?

Does the bird that made these tracks walk or hop on the ground? Why?



What type of animal made these tracks?

Activity 6:

What do tracks in the snow reveal about the animal that made them?

Find fresh sets of animal tracks in the snow.

Sketch one set of the animal tracks for your field records. Place an *acetate* sheet (from an overhead projector) over the track and trace it.

You might transfer this tracing onto graph paper. Be sure to sketch the track so that it shows the proper size of the tracks, all of the footprints, any claw prints that you observe, and the depth of the tracks in the snow.

Measure the distance between each set of tracks.

Measure the depth of the tracks in the snow.

Follow the animal tracks.

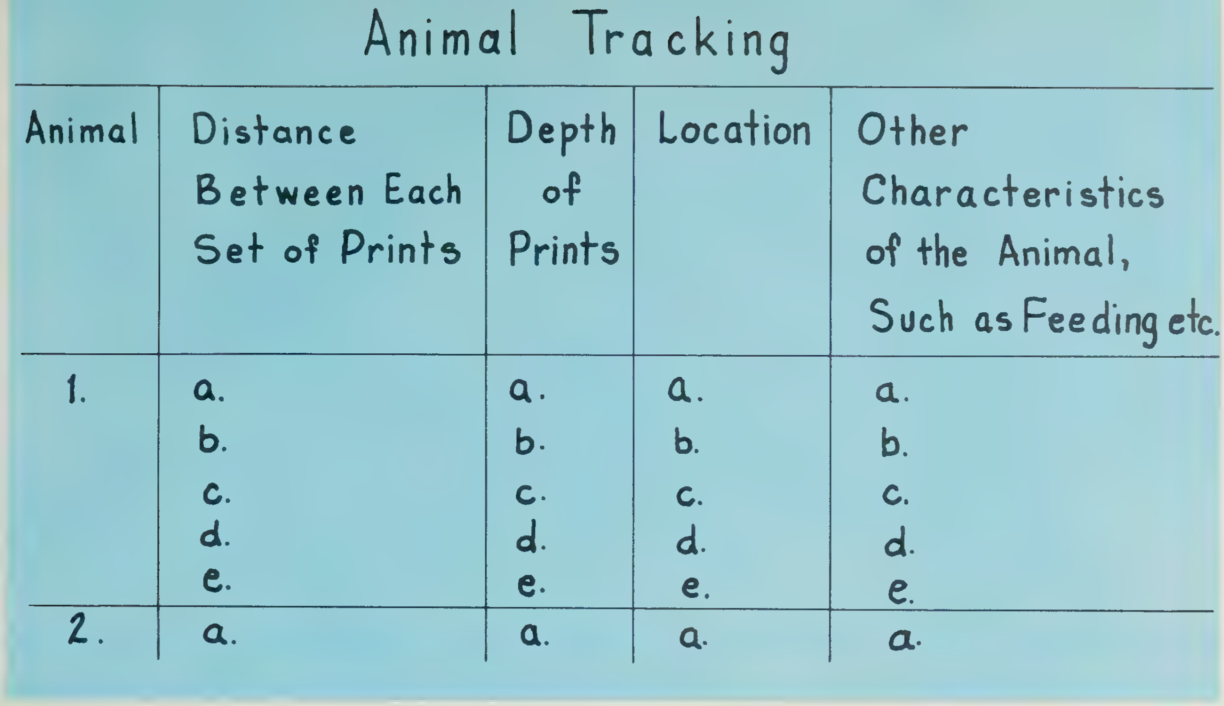
After making several measurements of the distance between each set of tracks and the depth of the prints, make a guess as to how the animal was travelling: walking, running slowly, running quickly.

Note any evidence of feeding and places that the animal visited.

When you return to your classroom, use all the information that you gathered to find out what animal made the tracks. There are many good books for identifying different types of animal tracks.

You might transfer your field records to a chart similar to the sample shown. Your sketches can be made on the opposite side of the chart page or on another sheet.

What materials do you need for this activity?



Animal Tracking

Animal	Distance Between Each Set of Prints	Depth of Prints	Location	Other Characteristics of the Animal, Such as Feeding etc.
1.	a.	a.	a.	a.
	b.	b.	b.	b.
	c.	c.	c.	c.
	d.	d.	d.	d.
	e.	e.	e.	e.
2.	a.	a.	a.	a.

Investigate several types of animal tracks in the same way.

Digging Deeper

Count the squares covered on the graph paper to find the size of each track.

What animals made the tracks that you studied?

Find the meaning of the word *habitat*.

What was the habitat of each animal that made the tracks?

How were the forelegs different from the hind legs of each animal?

From your observations of the tracks, how is the animal that made them adapted for movement? Is it a climbing animal? burrowing animal? flying animal? running animal? jumping animal? Explain your answer.

If you studied bird tracks, what evidence of flight did you find?

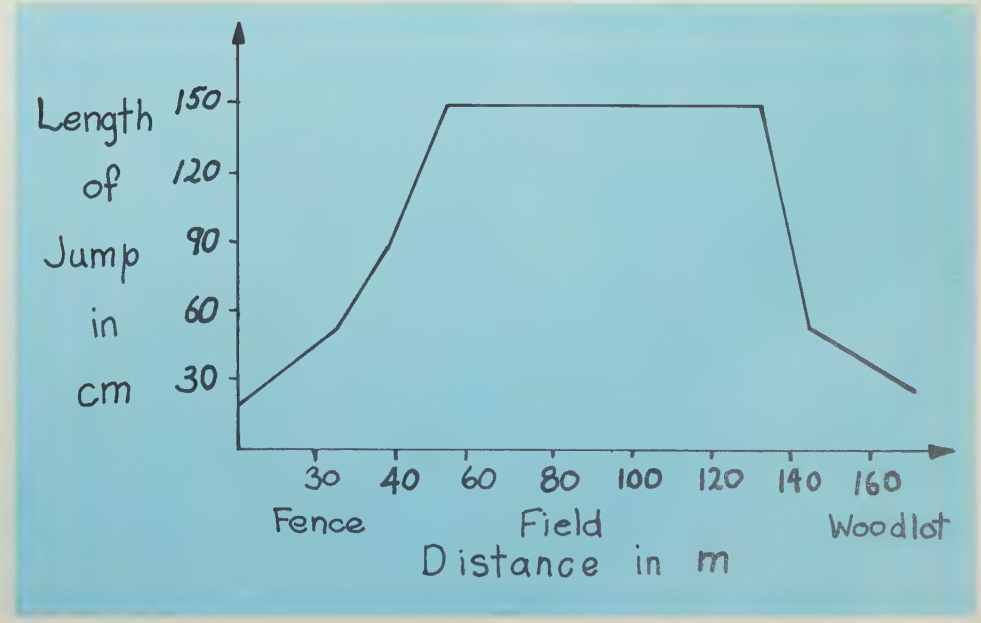
How does the animal move its legs when it is walking? running?

Did the animal stop to browse along the way? Why?

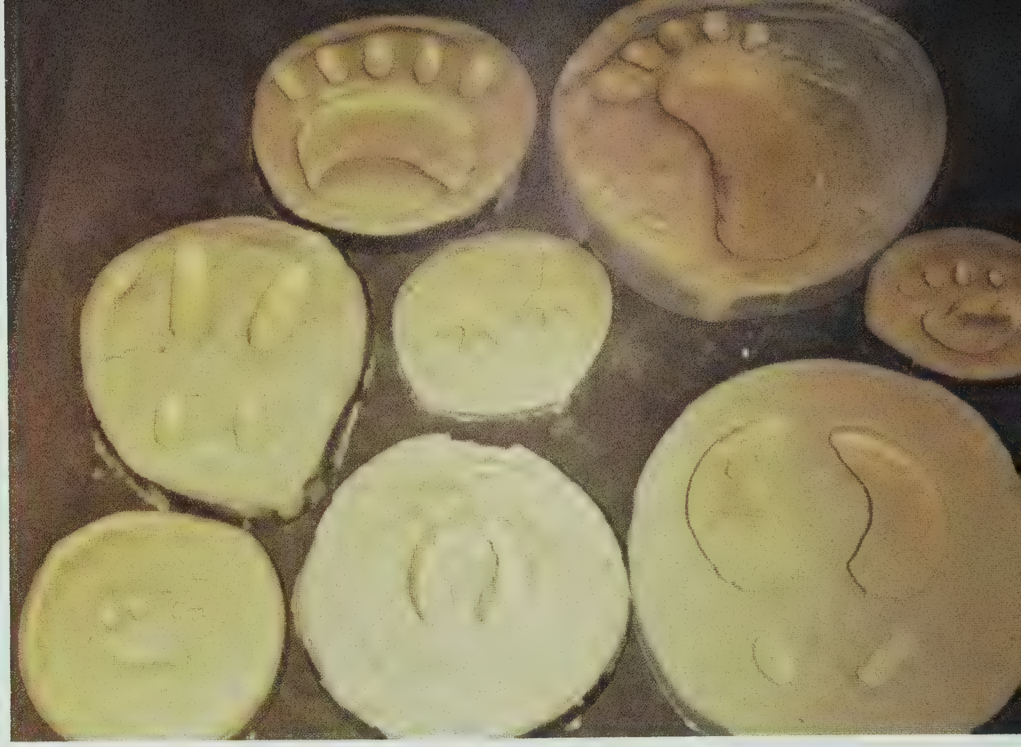
Were there any differences in the tracks in open areas compared to the same tracks in more protected areas? Why?

How large do you think the animals were that made the tracks? Why?

The following graph shows how one animal moved from a fence, across a field, to a woodlot. What does this data indicate about the type of animal that was studied?



What common woodlot animals could have made the tracks that were improvised by the students?



Branching Out

How can animal tracks be collected?

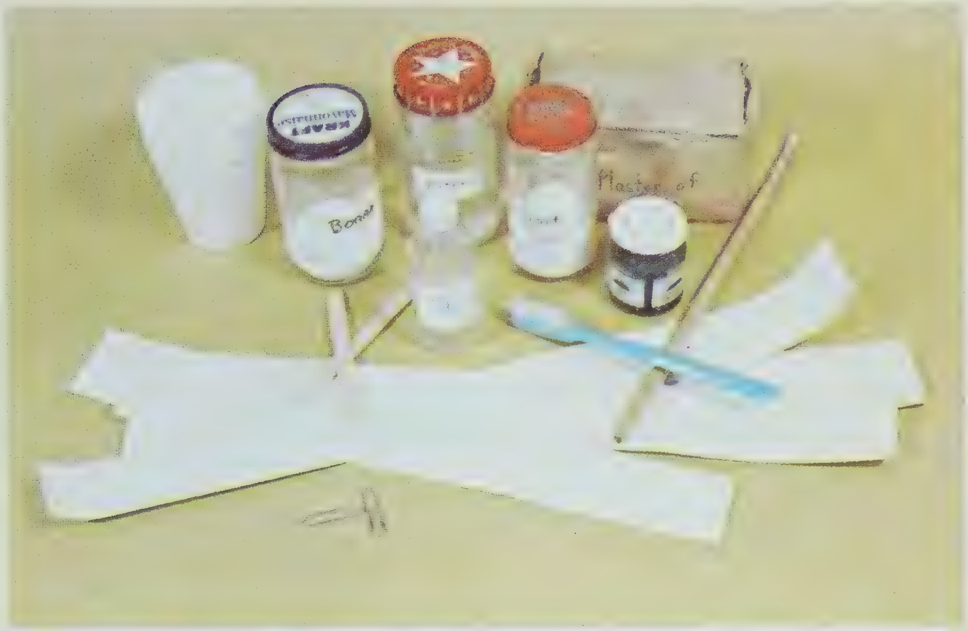
Animal tracks can be recorded in plaster of Paris casts. After you have made several casts of different animals' tracks, you will have a permanent and interesting display.

Sometimes good tracks of interesting animals are difficult to find. To solve this problem, some students used reference books on tracks and improvised prints in their plaster of Paris casts.

Find a suitable track of which you would like to make a permanent record. It should be fresh, clearly formed, and located in firm packy snow that is at least 3 cm deep. Clean any debris from the track, and reconstruct parts that may be damaged. Spray the track with a fine mist of water from a window cleaner bottle so that a thin layer of ice will form on the track to support the plaster of Paris. How will you prevent the water in the applicator bottle from freezing on your way to the track? You might use a can of hairspray which will cover the track with a plasticlike coating.

A student is spraying a set of tracks with water in the photograph on the left while on the right, hairspray is used. Is one method better than the other?

Materials needed for making plaster casts of tracks.



Prepare a collar from a piece of Bristol board. It should be cut into a 5 cm strip, as long as necessary to completely encircle and overlap the track. Fasten it together with a paper clip or a bobby pin and insert it 3 cm into the snow around the track.

Plaster of Paris can usually be found in the art or science supplies in a school. If not, it is very inexpensive and can be purchased at most hardware stores. Try to buy a slow drying kind.

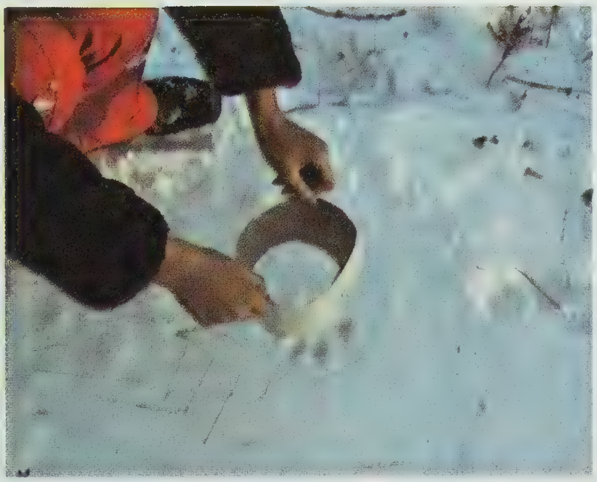
Mix the plaster of Paris and water in a styrofoam cup or other disposable container. Make small amounts by adding water to the plaster a little at a time. Stir the mixture until all of the lumps are removed and it resembles whipped cream. The addition of salt from a shaker will speed up the hardening process, but this should only be done just before you pour the plaster.

Pour the plaster into the collar, filling the track first. Tap the collar gently to ensure that the plaster flows into the tiny areas, like any claw marks. The tapping will also help to force air bubbles to the surface.

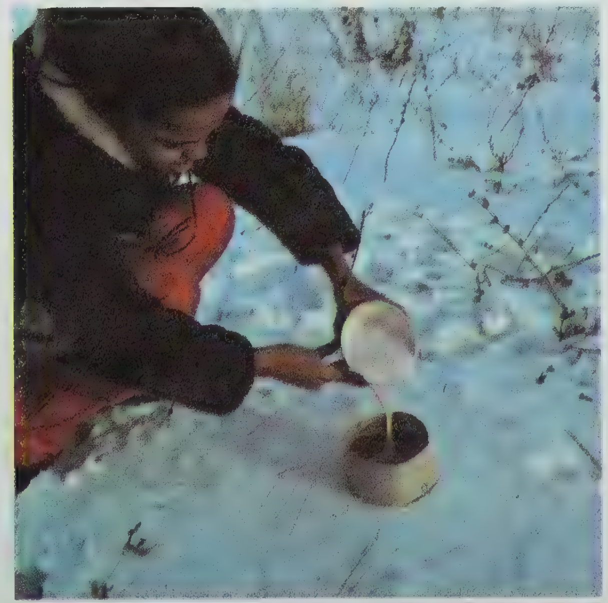
Fill the collar to a depth of 1 to 2 cm. Insert a paper clip at an angle into the wet plaster. This will make it easy to hang the cast on a wall after the plaster has hardened.

Leave the plaster cast for at least an hour to completely harden.

Remove the track from the snow and peel off the collar. Be sure that the face of the track has hardened before you clean it.



What purpose does the collar serve?



Why is it important to perform the mixing and pouring operation as quickly as possible?

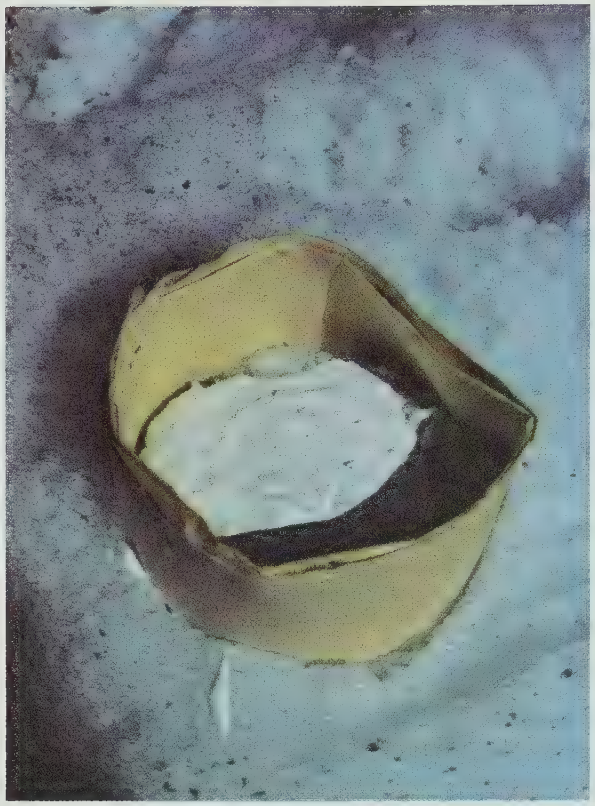
Boil the plaster cast in a solution of Borax (15 ml to 500 ml of water) for 20 min to harden the plaster cast even more.

Use the appropriate colours of tempera powder to paint the casts the natural colours of the animals' feet.

After the paint is dry you can varnish the casts so that the finish will be preserved.

The plaster cast is now ready to be hung on a wall or some other display area like a science corner or museum.

You could cut pictures from magazines of the animals that made the tracks and mount them beside the plaster casts. An interesting puzzle for the other students would be for them to match the appropriate plaster cast to the correct animal picture.

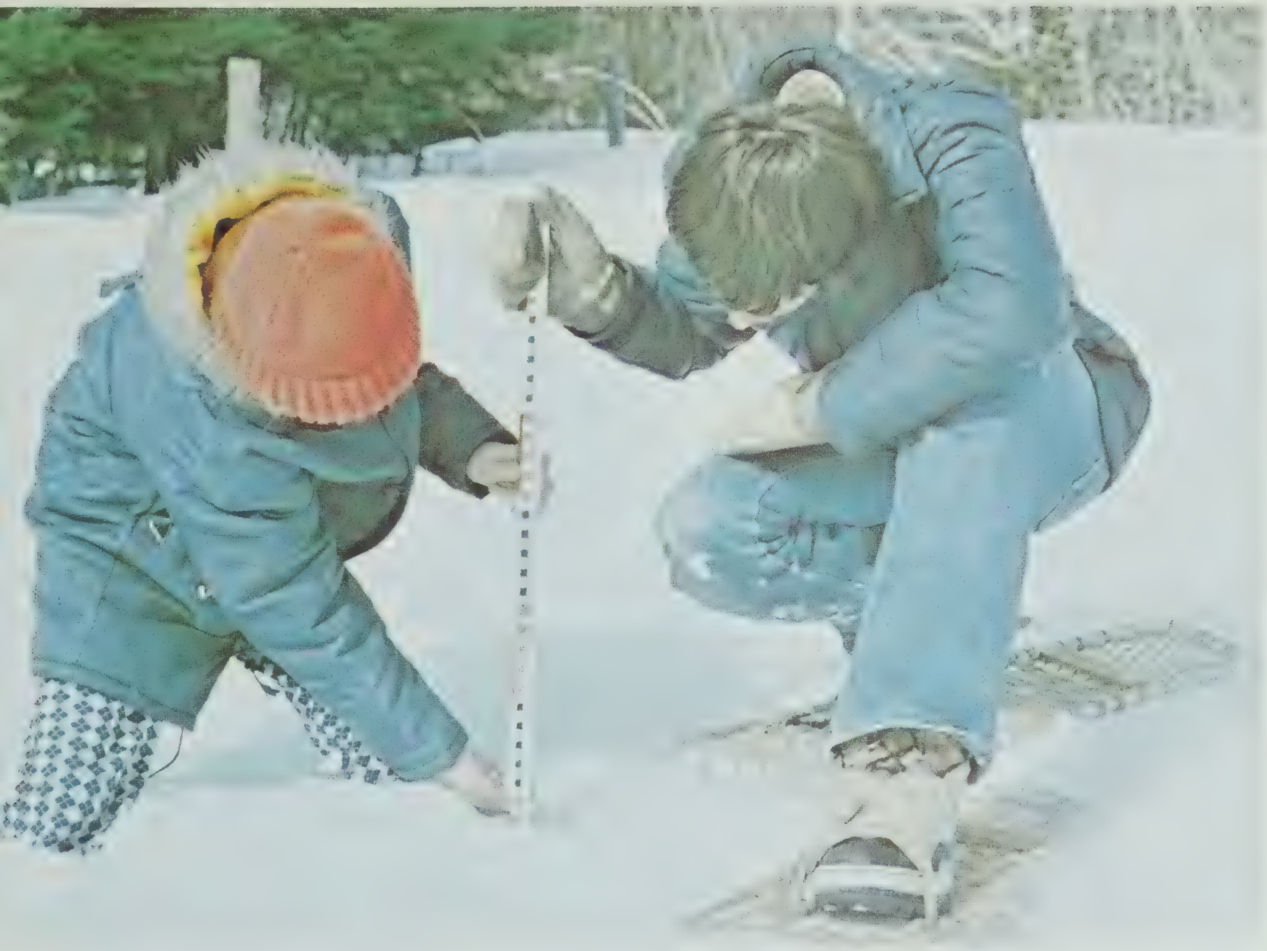


How will this plaster cast be hung when it has hardened?

Snowshoes

You probably know how difficult and uncomfortable it is to walk in deep snow. Travelling in snow posed a serious problem for North American Indians and Eskimos since, at one time, walking was the main means of transportation. To solve this problem, they developed the use of snowshoes which enabled them to walk on top of the snow without sinking into it. Today, snowshoes are still used but mostly for recreation. Perhaps you could learn more about the history of snowshoes from books in your school or public library.

How would you have to change your style of walking on snowshoes?



How could these two boys improve their experiment?

Activity 7:

How do snowshoes enable people to walk on deep snow easily?

Borrow a pair of snowshoes. Some likely sources might be: a local hunter, a high school physical education department, a recreation centre, an outdoor education school, a conservation authority, a parent interested in the out-of-doors.

Care should be taken in using snowshoes since they can be easily damaged.

Take several practice walks on deep snow where there are no rocks, gullies, or protruding branches that can damage the snowshoes.

Find an area where the snow is quite deep. Stand in the snow without the snowshoes.

Measure the depth of your tracks.

Repeat the same activity in the same place but this time use the snowshoes.

How deeply did you sink in the snow?

In your classroom trace the perimeter of one of your boots on a large piece of graph paper, 50 cm square. Inside the tracing, record the number of centimetres that you sank into the snow without snowshoes.

Trace the perimeter of one of the snowshoes on another large piece of graph paper. Similarly, record the depth of the track that you made in the snow while wearing snowshoes.

Count the number of square centimetres that supported your body's mass in each case. Compare the area of support with and without snowshoes to the depth of each track.

Digging Deeper

How much further did you sink into the snow without snowshoes compared to with them?

Can you explain how snowshoes enabled you to walk on top of the deep snow without sinking?

Make a solid pair of snowshoes the same size as the regular snowshoes. They could be cut from 1 cm plywood with an old belt used as bindings. How well do they work compared to the regular snowshoes?

How did you have to adapt your walking style in order to use the snowshoes effectively?

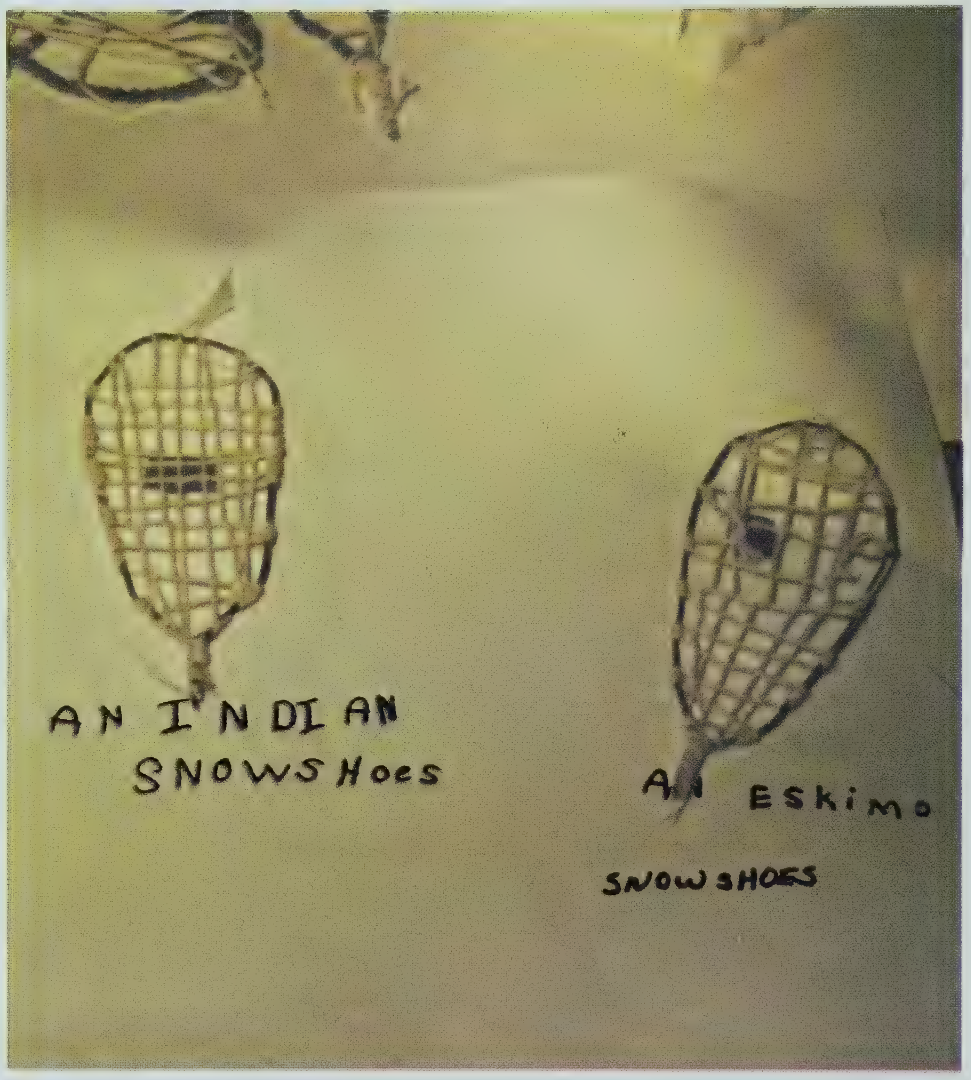
Compare the speed at which you can travel over a given distance with snowshoes and without snowshoes?

What effect does mass have on the depth to which snowshoes will sink into snow?

What is the best type of snow for using snowshoes?

What different types of snowshoes are made?

If you were unable to borrow real snowshoes, the above photograph might give you an idea for performing the same experiment outlined in the activity but using masses and a model of a snowshoe.



A student made these models of snowshoes from a coat hanger and some string. What differences does he illustrate between Indian and Eskimo snowshoes?

Ice Cold

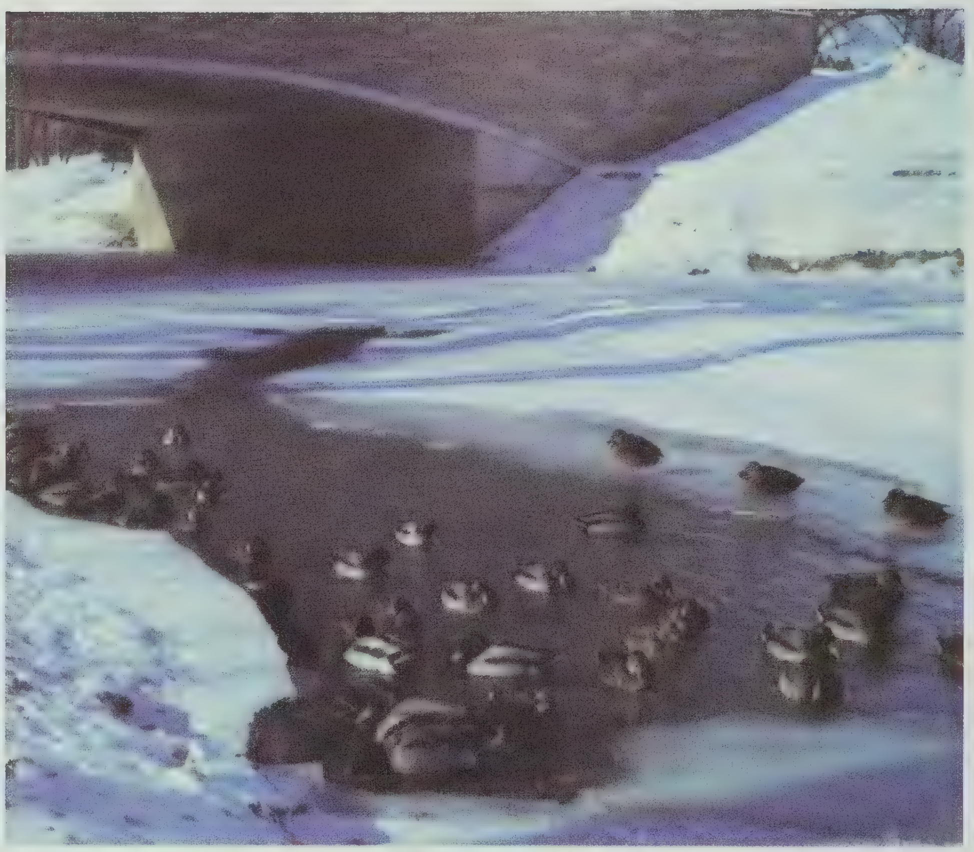
3

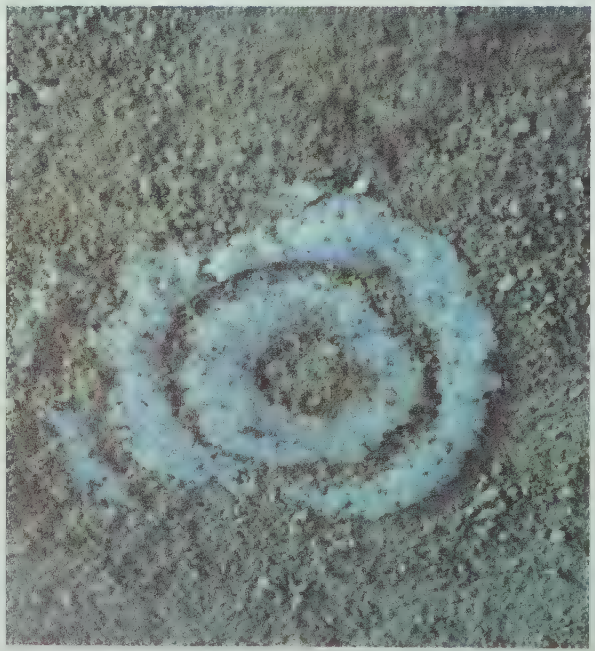
3. Ice Cold!

To many people winter means snow, ice and bitter cold. The coming of winter causes people to change their habits quite drastically. They dress differently, behave differently, eat differently, play different games, and many even seem to hibernate indoors during the winter months. All of these changes in our everyday living are the result of a decrease in temperature caused by the change in season. Find out what causes the different seasons.

In the following series of photographs you will recognize familiar winter phenomena. Frost and ice are evident in some of the pictures as they form unusual patterns in unusual places. In the other photographs ice cannot be seen but the effects of extreme cold are obvious. In order to understand how the phenomena occurred you will need to understand some of the processes that happen when changing temperatures cause water to change its form or state. Water has three states. Normally water is a liquid, but when it becomes colder than 0°C, it changes its state to a solid (ice). Water can also exist as a gas in the air and is then called water vapour which can be understood when you think of a boiling kettle giving off steam which disappears as vapour into the air. When water changes state to water vapour, the process is called *evaporation*. However, when water vapour comes in contact with a cold surface, it changes back to water in a process known as *condensation*. Of course, when water becomes a solid, we refer to the change as freezing. Whenever a change of state takes place

How have these ducks been able to keep a patch of water from freezing so that they can survive?

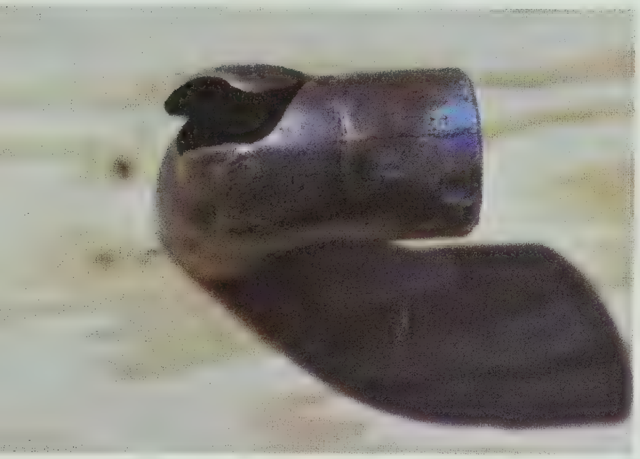


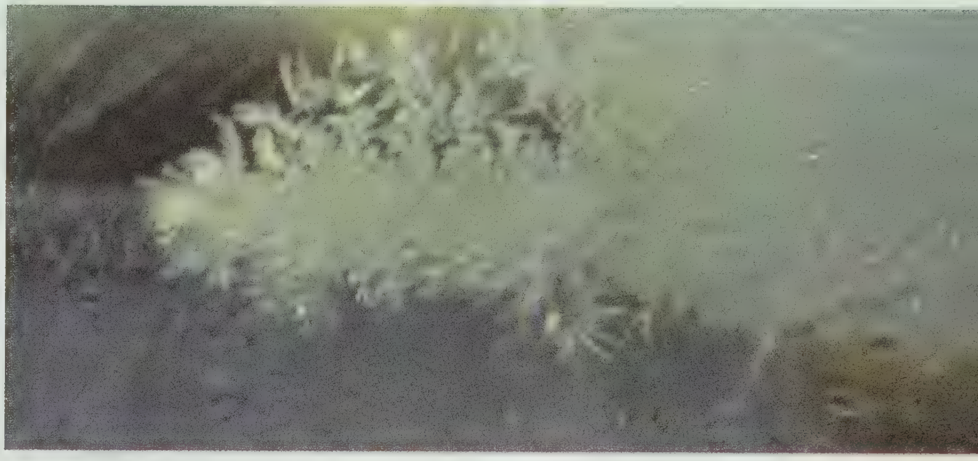


What do you think caused ice to form in this interesting way on the side of a street?

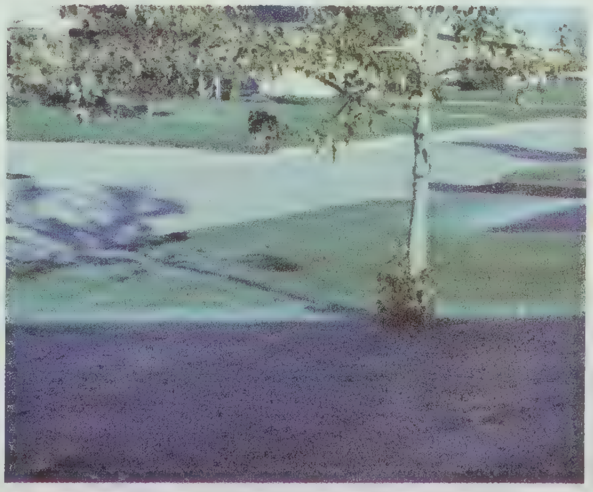
How was the fog caused differently over the bay during the winter and over the hockey rink during the summer?

Why would frost form on the inside of this window?

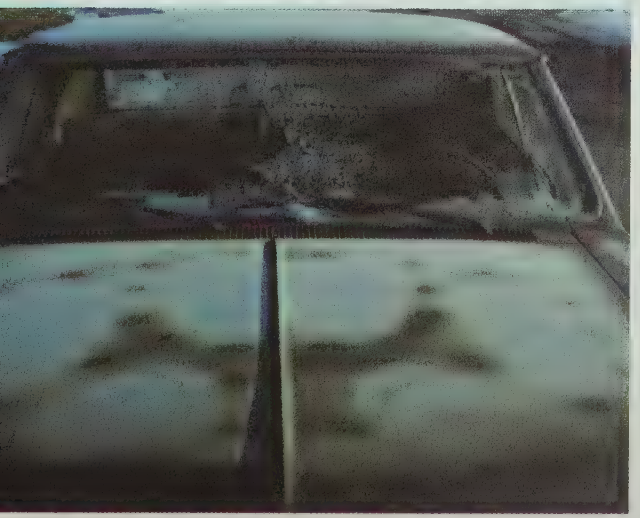




This copper pipe elbow was used to connect two water pipes to an outdoor fountain. How did cold cause the elbow to split?

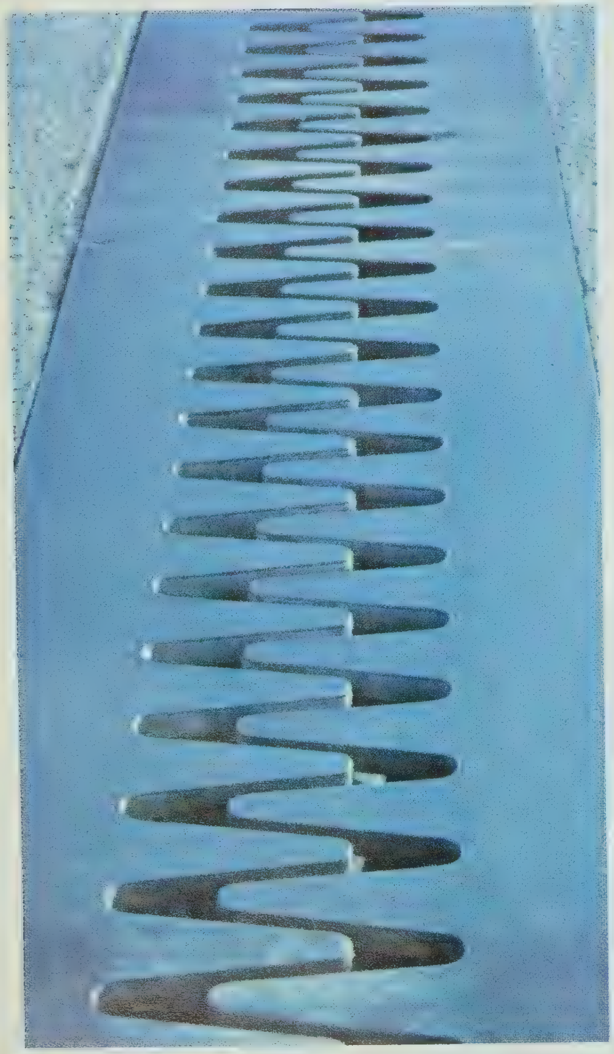


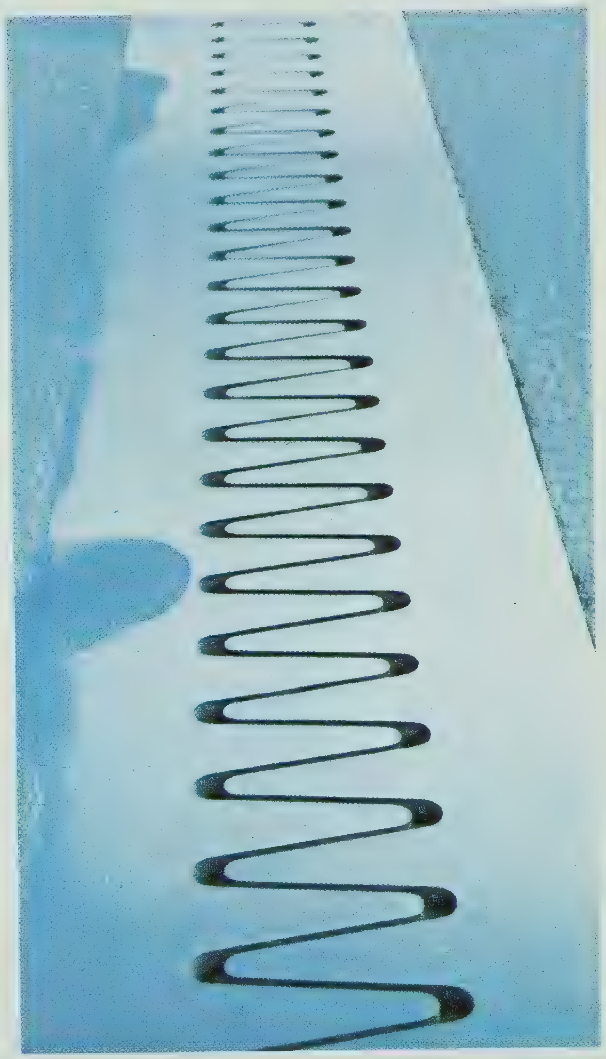
Why is the frost on the grass only in the shaded areas?



The frost formation on the car hood gives evidence as to where the metal supports can be found on the underside of the hood. Why did this particular pattern form?

These two photographs show the same expansion joint on a bridge in two different seasons. During which season was each photograph taken?





the volume of the solid, liquid, or gas also changes as it expands (increases) or contracts (decreases). Use this information to help you answer the questions that accompany the photographs.

What interesting effects of temperature can you find around your home or school?

The activities in this chapter have been designed to guide you in investigating just how cold winter really is. However, if you become very interested in some of the photographs at the beginning of the chapter or, better still, some puzzling problems caused by freezing cold around your school, do not hesitate to launch your own scientific investigation.

Activity 1:

How cold is snow?

Take the temperature of snow in different places around your school. Remember to leave your thermometer in the snow long enough for the liquid in the column to adjust itself to the new surroundings. If you decide that 2 min is long enough, then you should use the same time limit for each area that you test. Care should also be taken to place the bulb of the thermometer in the snow to the same depth each time.

Take the air temperature as you test each snowy area.

Some areas that could be tested are: snow in the sun, snow in the shade, clean snow, dirty snow, new snow, old snow, loose snow, snow that has been compacted by cars or boots, fluffy snow, slushy snow, packing snow.

Predict the range of temperatures that you expect to find.

Why should all of the temperature readings be taken during the same weather conditions?

Record your results on a bar graph.

Digging Deeper

What range of temperatures did you find for the areas of snow that you tested?

What was the average temperature?

How did the temperature in each case compare to the air temperature?

Were any of the snow temperatures above 0°C?

What reasons could you suggest for temperature readings that were not 0°C?

Activity 2:

What is the effect of salt on snow?

Collect a container of snow and record the temperature of the snow.

Obtain some table salt and record its temperature. Mix 15 ml of salt into the container of snow.

Record the temperature of the snow again.

Continue adding equal amounts of salt to the snow and recording the temperatures until there is no further change.

Why was it a good idea for these students to perform this activity outdoors?

Digging Deeper

How did the temperature of snow change with each addition of salt?

Did the temperature of the salt affect the temperature of the snow?

What happened to the snow in the pail as time passed?

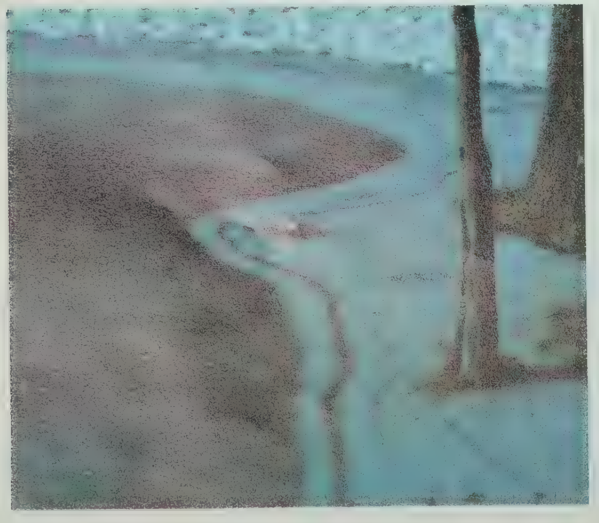
What effect does salt have on the temperature of snow?

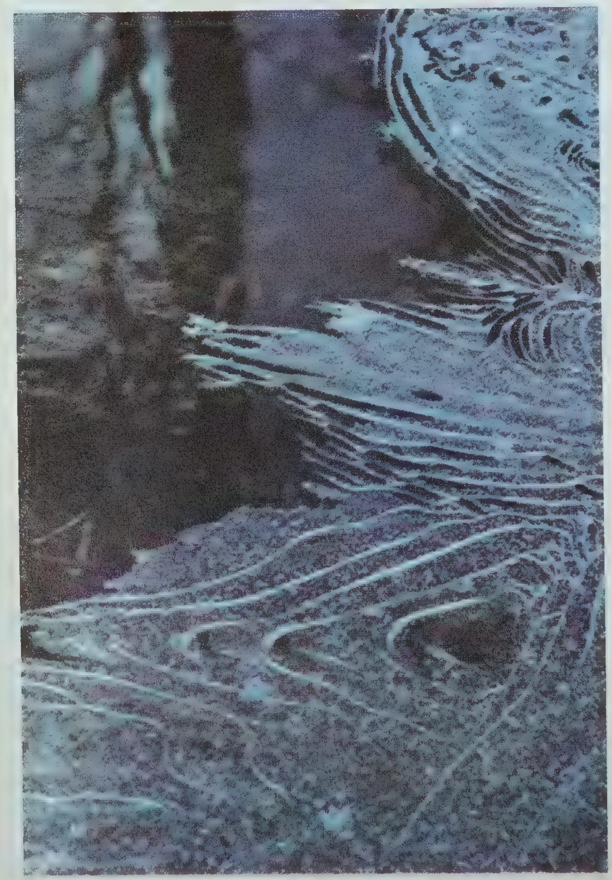
When rock salt is spread on icy and snow covered roads and sidewalks, why are they safer for vehicles and pedestrians?

As you performed this activity did anything form on the outside of the snow container? Why?

Ice Formation

Perhaps you have noticed that ice forms in peculiar ways in ice cube trays, on icicles, in ditches or on small puddles and streams. Study these photographs and describe how the ice is forming in each case.





How is the ice forming in these photographs?

Activity 3:

How does ice form?

Shape a small pan from a piece of tinfoil or obtain a tinfoil tart pan.

On a cold day, place the tinfoil pan in some snow outside, and fill it with water.

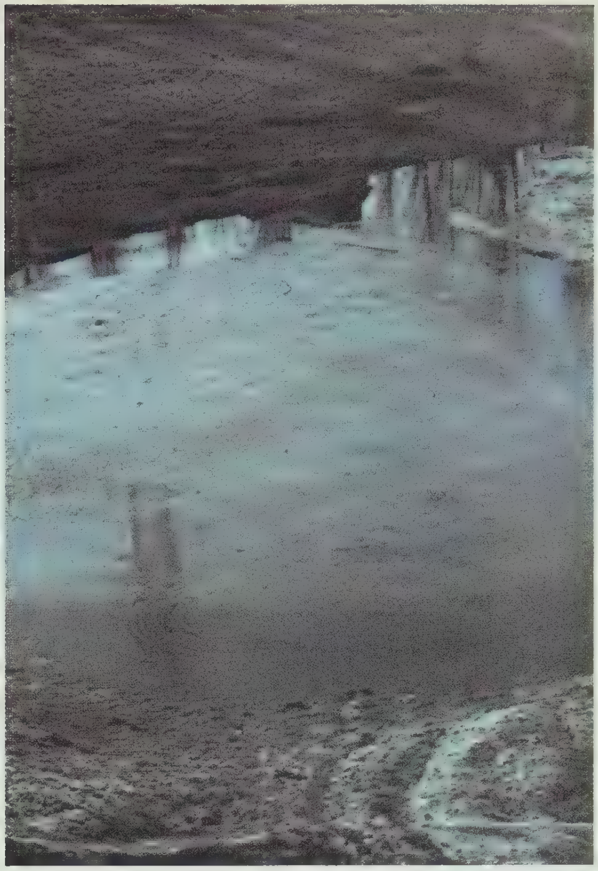
Use a hand magnifying glass to help you observe what happens in the pan. Make sketches to record the changes in the pan of water.

Digging Deeper

Where does ice first form?

How long did it take before you first observed ice forming?

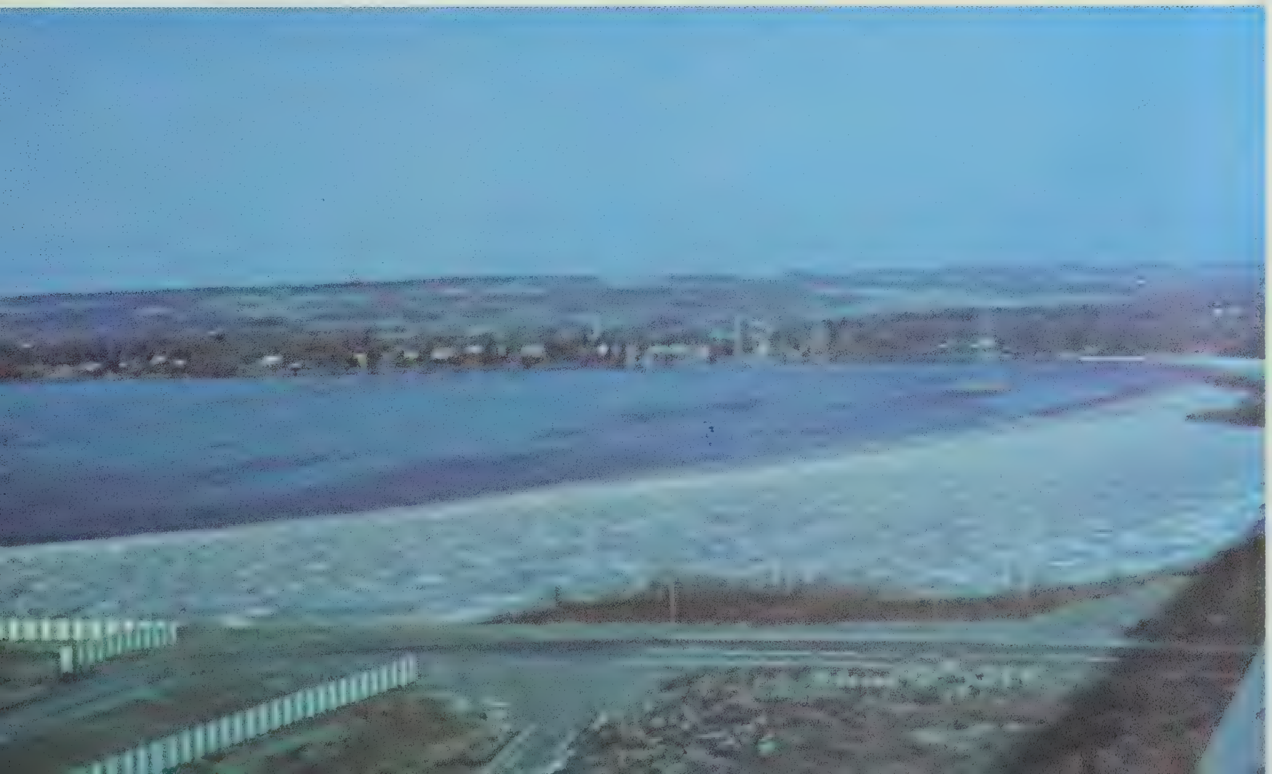
As the water began to freeze, in what two directions did the ice spread?



During what season was this photograph taken? Explain your answer.

Describe the shape of any ice crystals that you observed.

How much time was required for the water to completely freeze?



During what season was this photograph taken? How do you know?

Activity 4:

Does hot water freeze more quickly than cold water?

Did you know that many skating rinks are flooded with hot water? Hot milk is used to make ice cream. Plumbers have noticed that hot water pipes often freeze and split before cold water pipes. There seems to be something strange about these reports. Do you think that they are unbelievable? An experiment to investigate such unusual reports should be performed before you make any judgment.

Collect two styrofoam cups of the same shape and size. You should also obtain two thermometers that indicate the same temperature when you place them on a desk.

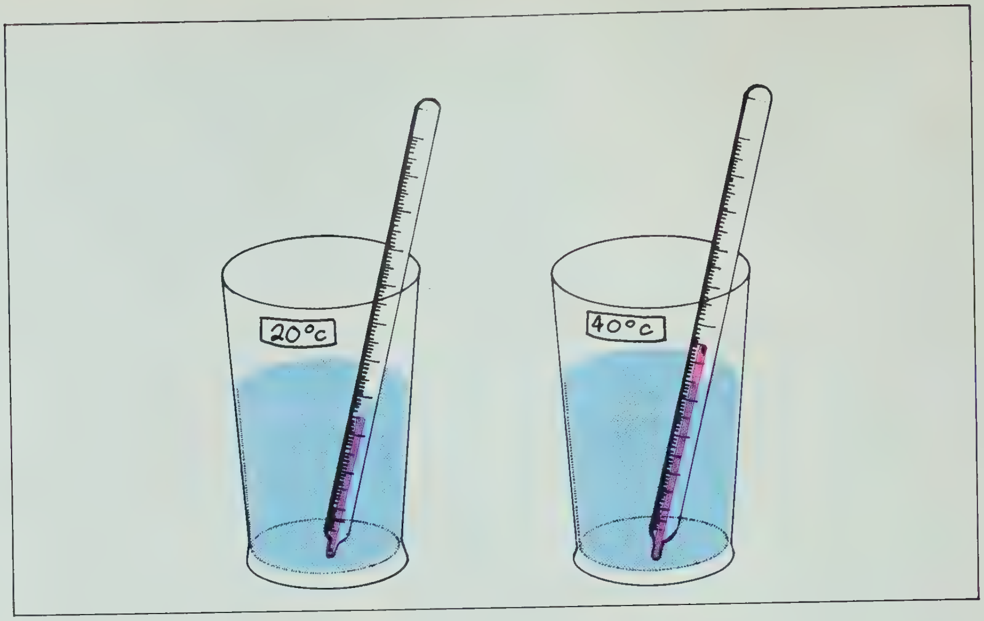
In one cup, combine both hot and cold tap water until the temperature is 20°C. The water level should be 3 cm from the top of the cup.

In the other cup, mix hot and cold water until the temperature is 40°C. How far should this cup be filled?

Label each glass with the temperature of the water.

As soon as the hot water (40°C) and the room temperature water (20°C) are mixed, a thermometer should be placed in each glass and both containers put in a freezer, or outdoors, on a very cold day. Why is speed important at this stage?

Read and record the temperatures every 15 min until the water in both glasses has evidence of ice on it.



Digging Deeper

In which container did freezing occur first?

How much time passed from the time the glasses were placed in the freezer until you observed freezing in each glass?

What was the difference in time required to start freezing in the glasses?

What was the temperature in each glass after ice appeared?

During what time period did you record the most rapid cooling?

Did you record any temperatures below 0°C?

Will glasses of water at 28°C and at 17°C require the same length of time to freeze? at 33°C and 11°C?

Will boiling water freeze more quickly than water at room temperature?

Is it a wise idea to place warm water outside for birds to drink during freezing weather? Why?

Can you suggest reasons why water at 40°C might freeze more quickly than water at room temperature? How could you test your answer?

Where do icicles usually form on cars?

Icicles

During winter weather, one of the most beautiful and interesting phenomena is the formation of icicles. These *ice sticks* grow with freezing temperatures and recede with thawing temperatures. Study the photographs of icicles in this section and try to answer the questions.

Activity 5:

Where do icicles form?

Take a short excursion around your school or home neighbourhood to look for icicles on several different types of buildings. When you find icicles, examine them from the sidewalk, and record your observations.

Determine the approximate age of the building (you might interview the owner to find the answer or guess from your own experience whether it is new, fairly modern, old, very old).

What is the colour and type of roofing material?

Where are the icicles located on the building?

Describe the appearance of the icicles.

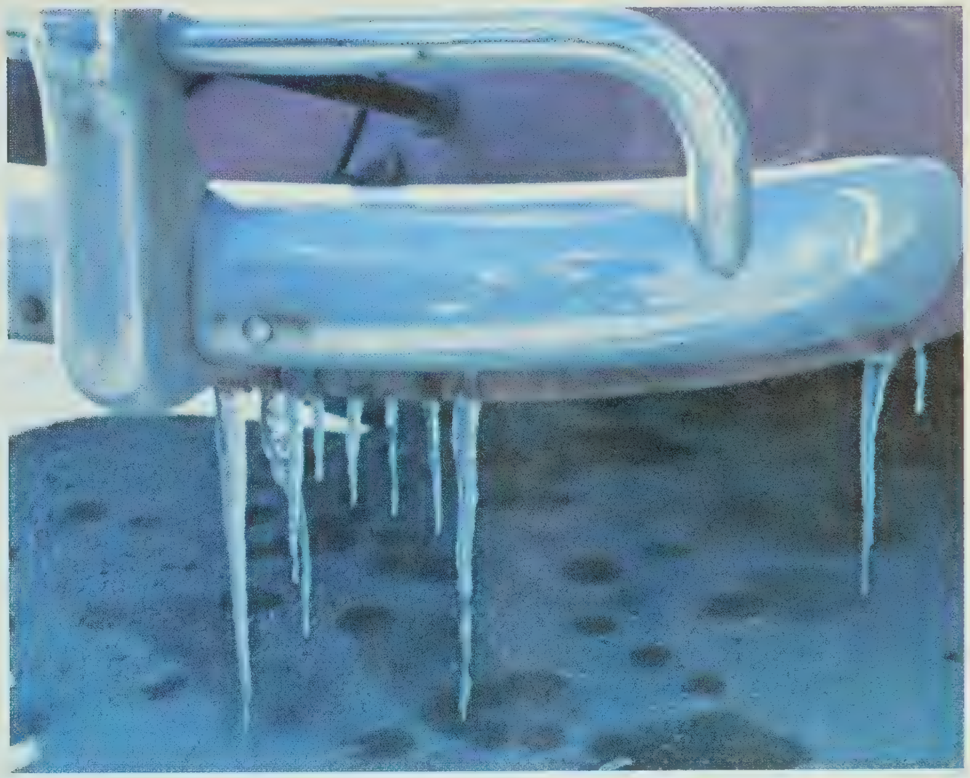
Is there any protection from the wind?

Find out whether insulation is used under the roof (interview the owner).

Digging Deeper

What is insulation?

How does insulation under a roof affect the formation of icicles on a building?

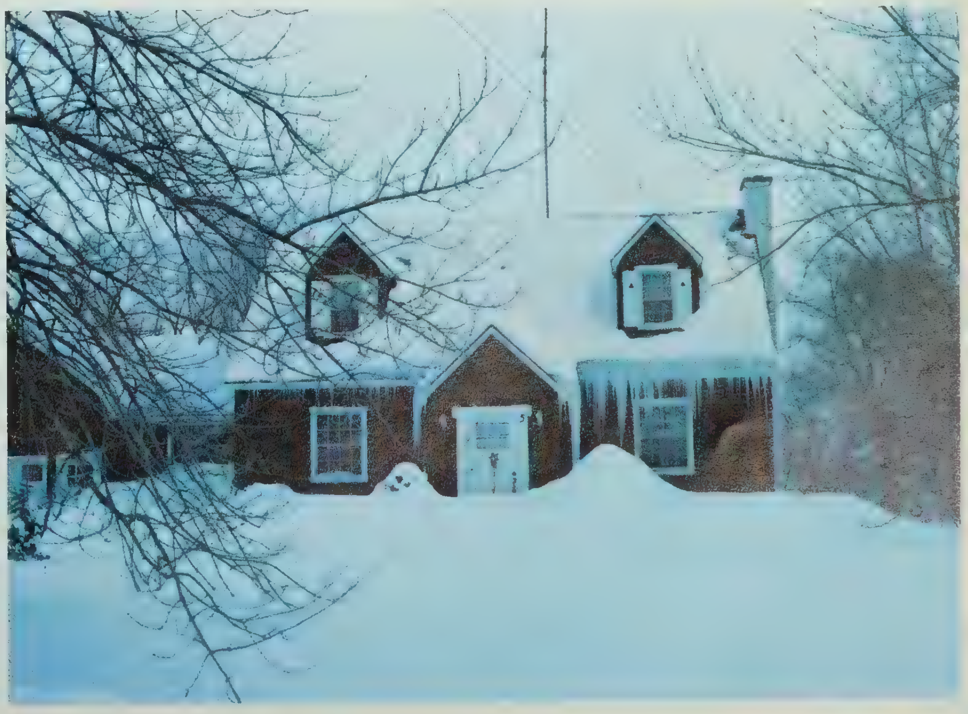


On what parts of buildings are icicles usually located?

How does wind affect the formation of icicles?

Describe the type of building where you would expect to find several icicles.

Why are there more icicles on one side of this house than on the other?



Activity 6:

What can be observed about an icicle?

Collect several icicles. Since icicles can be dangerous if they fall, be very cautious and collect them under the supervision of an adult. If you want icicles that are on a building, ask the permission of the owner first.

Icicles that will not be studied immediately should be placed in a freezer.

Place an icicle in a container like a foil pie plate to collect the melt water.

Describe how the icicle feels.

Describe its appearance both with and without a hand magnifier.

Use a saw or sharp knife to cut across the icicle. Describe the cross section.

Try to bend your icicle. Try crushing it.

Digging Deeper

Why are icicles not always smooth like a sheet of ice?

Why are some parts of an icicle whitish in colour?

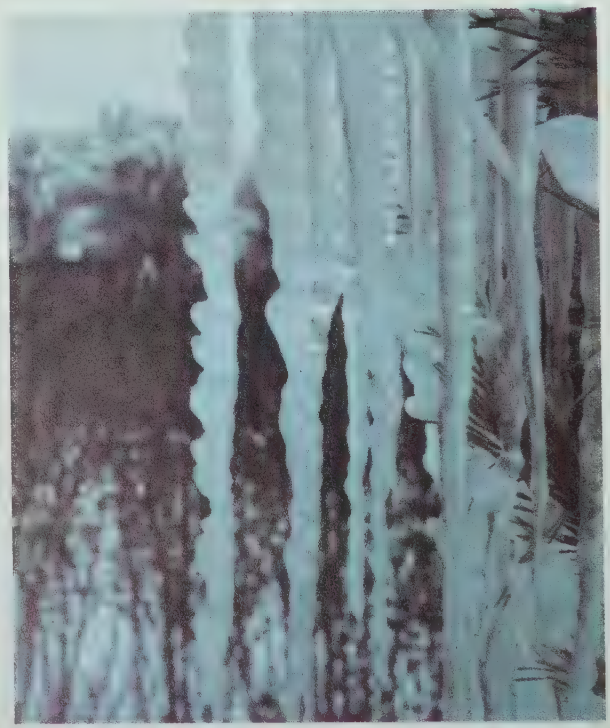
What causes the layers in the cross section of an icicle?

What did you do to make the icicle bend?

How does an icicle break?

Compare your findings with other students who performed the same activity.

What would cause icicles to hang from the drifted snow on the roof?



What do you think caused the saw-toothed nature of some of these icicles?

Activity 7:

What can be measured about an icicle?

Use icicles that you have collected for these investigations.

Find the temperature of an icicle at five minute intervals until it has completely melted.

Measure the length of the icicles that you collected to find the average length.

Measure the diameter of an icicle at 5 cm intervals from its base to its tip and make a graph of the results. A pair of calipers could be borrowed from a woodworking shop or from home to measure the diameters.

Find the mass of an icicle before and after it has melted.

Measure the width of each layer in the cross section of an icicle.

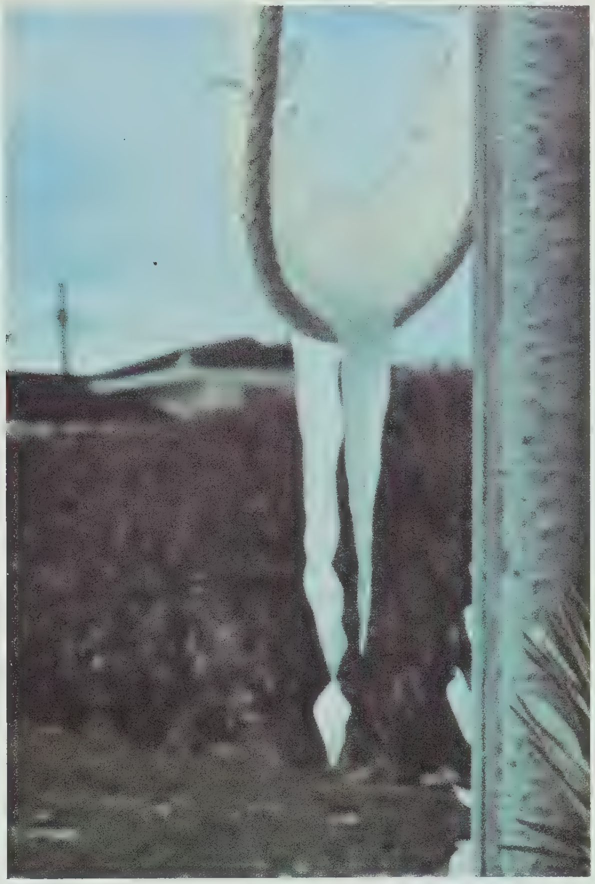
Digging Deeper

How does the temperature of an icicle change as it melts?

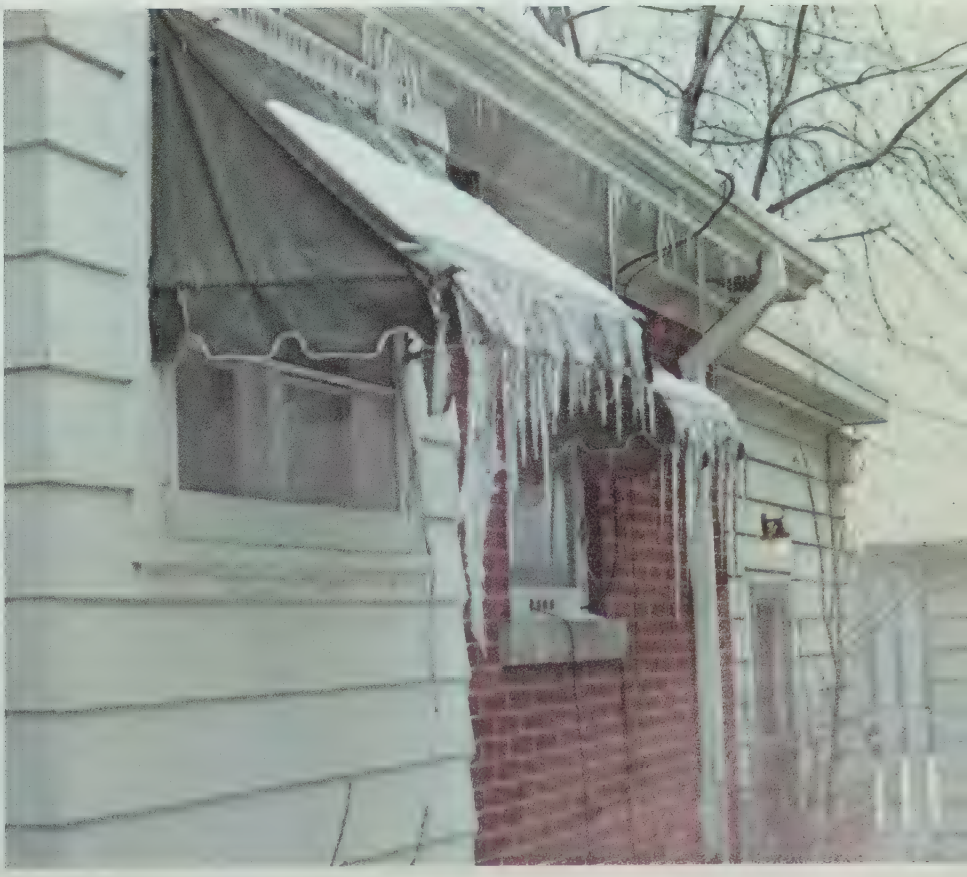
Describe the line or curve of the graph on which you plotted the diameter and length of an icicle.

Is the mass of an icicle the same before and after it melts? Explain your answer.

Why are the layers of ice in the cross section of an icicle different widths?



How would you explain this unusual icicle formation?



Why are the icicles hanging from the awning of different lengths?

How is this photograph similar to what you might see in a cave?

Activity 8:

How is water from an icicle different from tap water?

Obtain two clean soft drink bottles that are the same size and shape.

Fill one bottle to the 10 cm level with water from a melted icicle and the other bottle to the same level with tap water. Label each bottle to show what kind of water it contains.

Let the bottles sit until the temperature of the water in both containers is the same.

Use an eye dropper to add 5 drops of the same type of liquid detergent to each bottle.

Place stoppers on the bottles and shake them vigorously for 30 s.

Measure the height of the suds in each bottle.

Digging Deeper

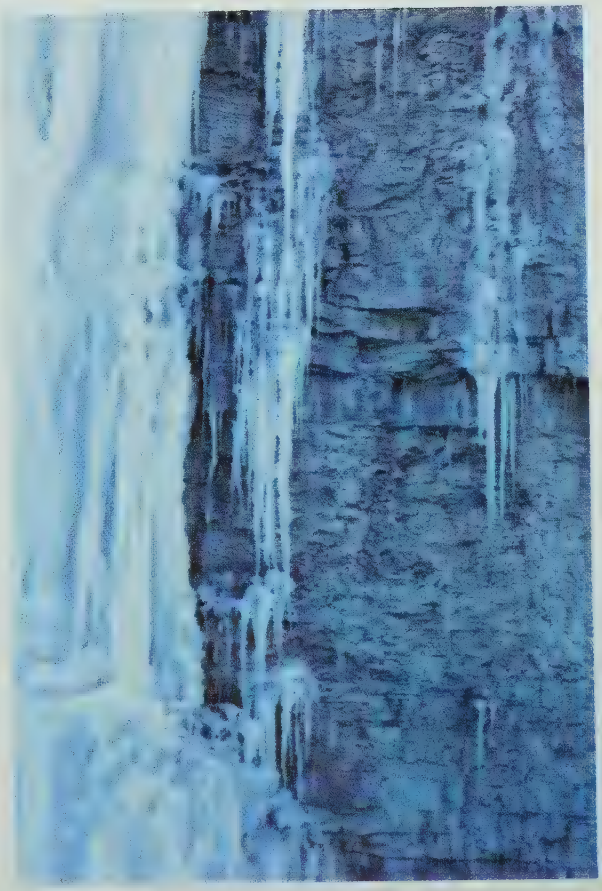
What differences did you observe in the amount of suds in each bottle?

Describe the appearance of the water in each bottle.

Why would melt water from an icicle not be suitable for cleaning purposes?

What other types of water would you expect to be similar to the melt water of an icicle?

What is hard water and soft water?



Why would icicles form on this wall of rock?

Winter Cold

Have you ever noticed how much colder you feel on a day when a strong wind is blowing than on a similar type of day when there is no wind? Sometimes these winter winds cause a biting cold that seems to go right through heavy clothing. A simple experiment can be performed to discover if wind really does lower the air temperature on a cold day.

Activity 9:

How does wind velocity (speed) *affect temperature?*

Choose a cold day when a steady wind is blowing.

Obtain two thermometers and compare their readings indoors before you begin.

Why should this be done?

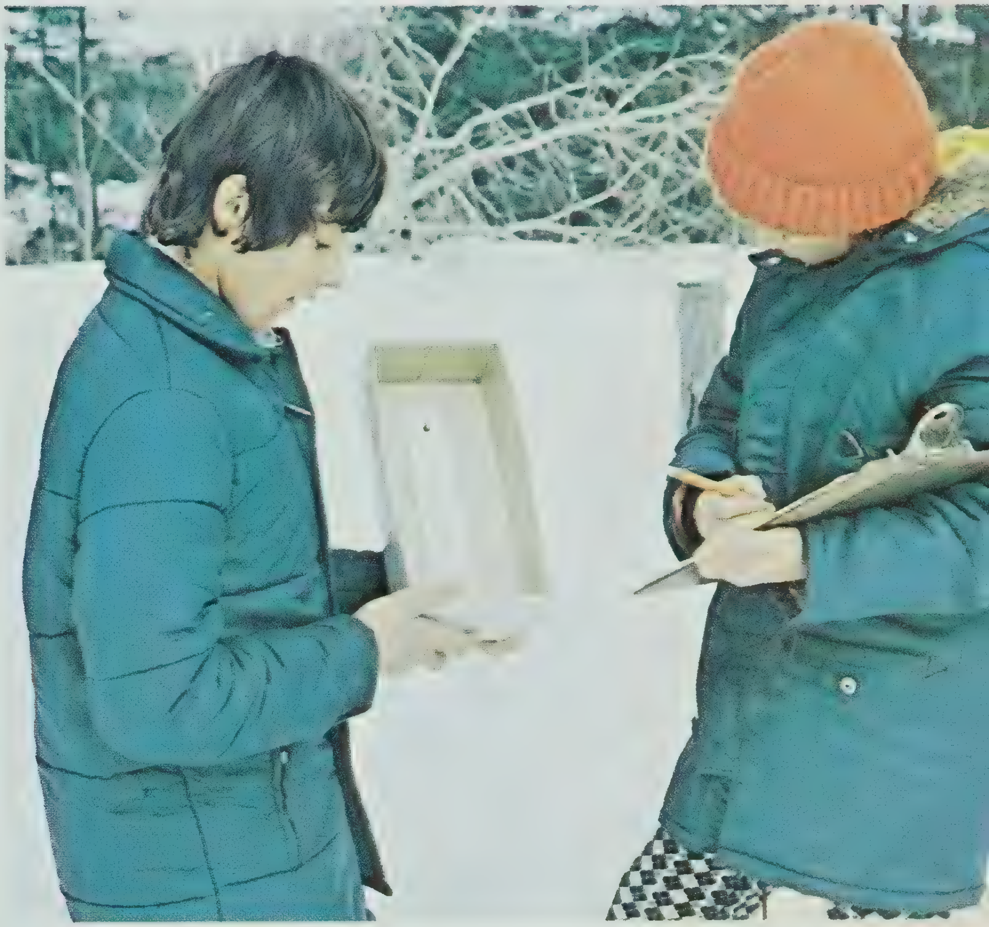
Tape one thermometer on the outside of an open shoebox and the other one on the inside of the box.

Take the shoebox and thermometers outside and hold the box so that the wind is blowing directly at the thermometer on the outside. No wind should be blowing on the thermometer inside. Why should the bulb of each thermometer be protected from the direct rays of the sunlight?

Compare the temperatures shown by the thermometers. How long should the thermometers be allowed to adjust themselves before readings are taken?

Repeat the activity in several areas around your school.

From which direction is the wind blowing in this photograph?



Digging Deeper

In each of the areas that you tested, what was the difference between the readings of the two thermometers?

What was the only factor that changed (the *variable*) in each area that you tested?

What factors remained the same (the constants) in this activity?

If the temperature readings for both thermometers were the same in each case, what do you think accounts for the fact that you feel colder when the winter winds blow?

Let a fan blow directly on the bulb of a thermometer for 20 min. Note the temperature before and after you start. What did you discover?

The degree to which a wind appears to lower the air temperature is referred to as the *wind chill factor.* The wind chill factor indicates how chilly you feel when a wind of a particular speed is blowing air of a particular temperature. The wind chill factor does not mean that the air temperature changes. It is similar to the change in temperature that you feel when you wet your finger in your mouth and raise it into the air to find out the direction of the wind. In this case, why does one side of your finger feel colder than the rest? Many local weather bureaus, radio and TV stations, and newspapers report the wind chill factor during the winter. The following activity describes how you can measure the wind chill factor around your area.

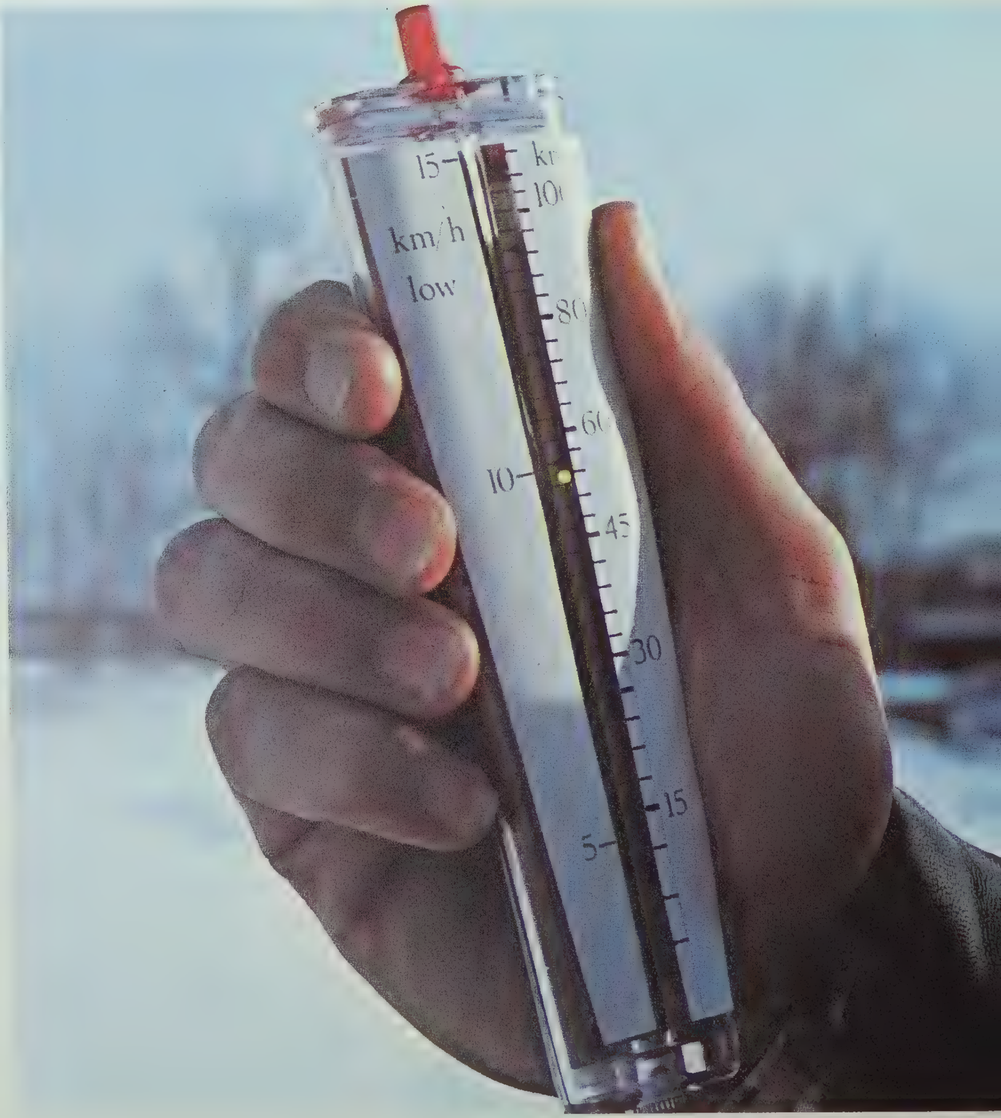
Activity 10:

What is the range of wind chill readings on your school grounds?

For this activity, choose a cold day when a steady wind is blowing. Examine your school grounds and determine ten points at which you will measure the wind chill. Include as many different areas as possible in your list. They might include places that are sunny, in the shade, near a building, under a tree, fully exposed to the wind, fully protected from the wind.

You will need a thermometer and an *anemometer* (a device to measure wind speed) to find the wind chill factor. The anemometer should be calibrated in kilometres per hour. One type that works well is called a pith ball anemometer. If you do not have a suitable wind speed device you might borrow one from a nearby high school or a senior science teacher in your school. Read the directions and practise using the anemometer before you start the activity.

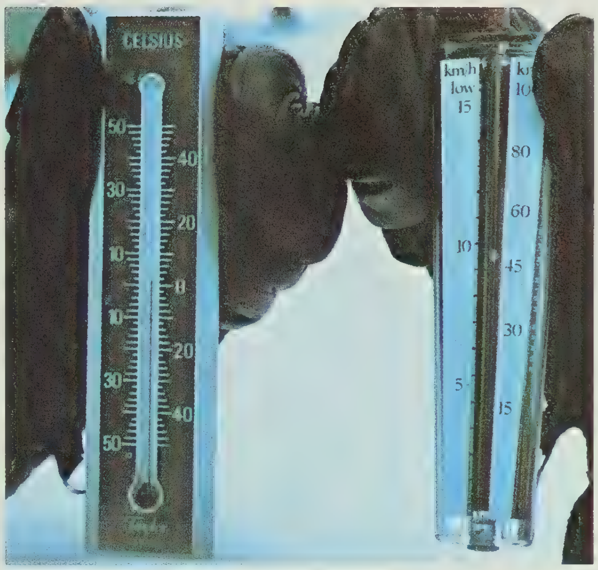
What wind speed is indicated on this pocket or pith ball anemometer?



Remember to face directly into the wind and to hold the device in a vertical position with the scale side toward you. Do not obstruct the holes at the bottom. If you need to use the high scale for winds greater than 15 km/h, cover the hole at the very top with your finger.

Take the wind speed and temperature readings at each of the ten points that you listed. In each case, take the readings at eye level.

Record your information on a wind chill data chart like the one shown.



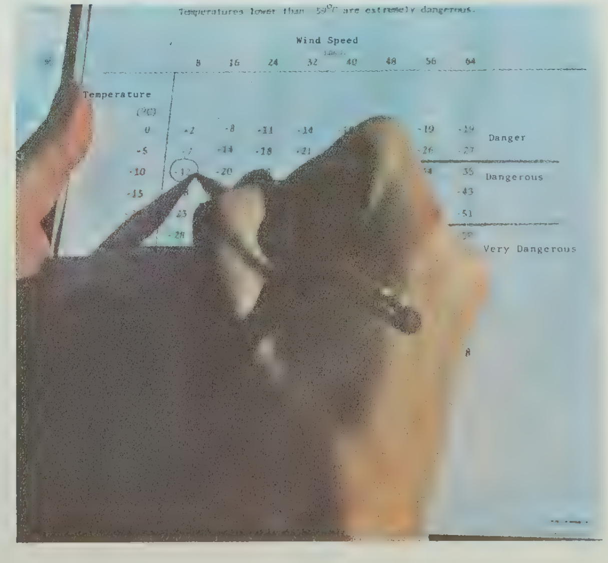
Why is it important that all readings should be taken at the same level?

Number	Type of Location	Temperature °C	Wind Speed	Wind Chill
1.	on top of hill -exposed to the wind – partly sunny	-10°C	8 km/h.	
2.				
3.				

On top of the hill

Temp: -10°C

Wind Speed: 8 km/h



Why was a wind chill of −12°C circled for the data collected on top of the hill?

WIND CHILL CHART

Thermometer Readings in Cardboard Box in Degrees Celsius

Wind speed in km/h

°C	0°C	-5°C	-10°C	-15°C	-20°C	-25°C	-30°C	-35°C	-40°C	-45°C	-50°C
8	-2	-7	-12	-18	-23	-28	-33	-39	-44	-49	-54
16	-8	-14	-20	-26	-32	-38	-45	-51	-57	-63	-69
24	-11	-18	-25	-32	-38	-45	-52	-59	-65	-72	-79
32	-14	-21	-28	-35	-43	-50	-57	-64	-71	-78	-85
40	-16	-23	-31	-38	-46	-53	-61	-68	-75	-83	-90
48	-17	-25	-33	-40	-48	-56	-63	-71	-79	-86	-94
56	-19	-26	-34	-42	-50	-57	-65	-73	-81	-89	-96
64	-19	-27	-35	-43	-51	-59	-67	-75	-83	-90	-98

Gradually increasing danger

Dangerous

Extremely Dangerous

Wind chill is the cooling power of wind on exposed living tissue expressed as an equivalent temperature (given here in degrees Celsius). For example, a thermometer reading of -10°C combined with a wind speed of 15 km/h is equivalent to a temperature of -20°C with no wind. Because exposed skin will freeze, temperatures below -30°C are considered dangerous. Temperatures lower than -59°C are extremely dangerous.

Apply the measurements that you collected for each area to the wind chill chart.

For a temperature of —10°C and a wind speed of 16 km/h the wind chill effect is equal to a temperature of —20°C. What would the wind chill effect be if the air temperature was —30°C and the wind speed, 24 km/h?

Digging Deeper

Where was the highest and the lowest wind chill reading found?

What range of wind chill readings did you discover?

Did the wind speed affect the temperature that you observed in each area?

Where would you expect to find a teacher who is on yard duty at recess on a windy winter day?

What is the average wind chill reading? How does this average reading compare to the wind chill factor issued by the local weather bureau on the same day?

Where would you expect to find small mammals when a cold winter wind is blowing?

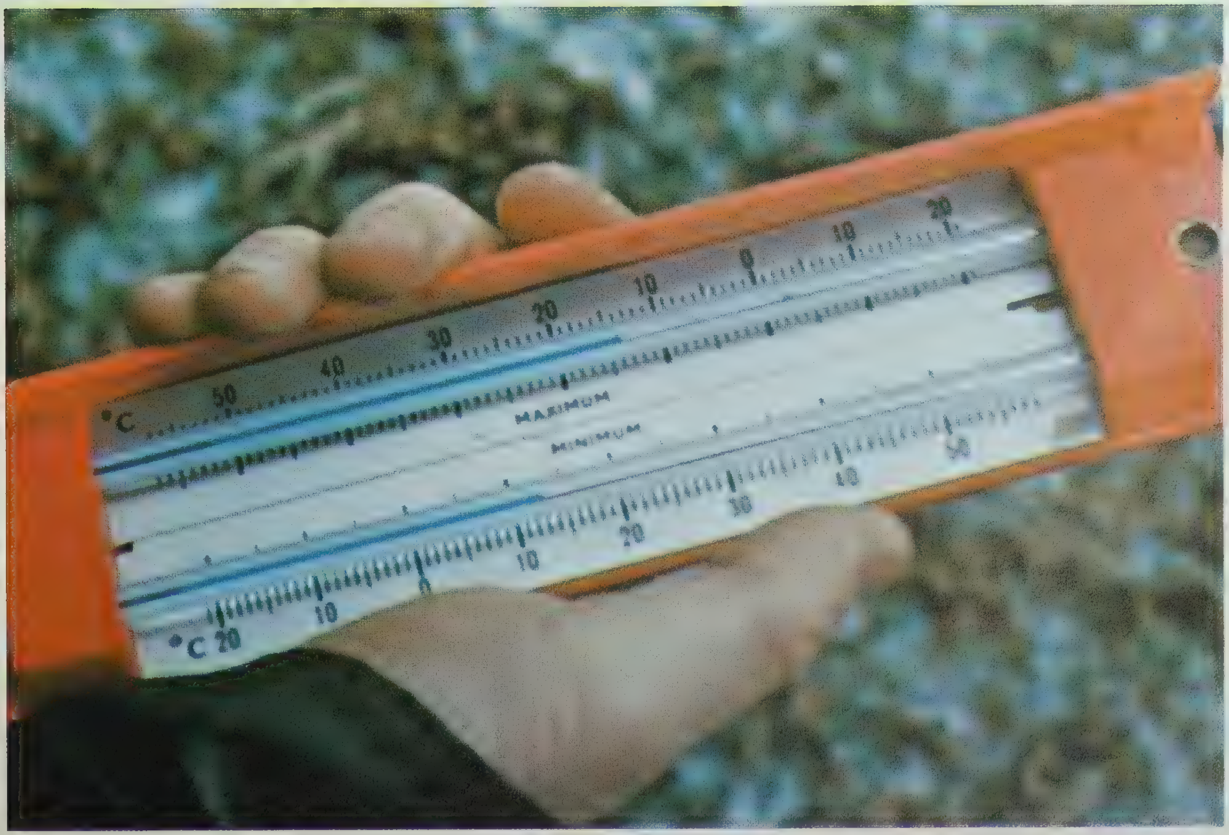
What effect do you think the wind chill would have on plants?

Are nonliving things like water pipes or rocks affected by the wind chill? Explain your answer.

Maximum and Minimum Temperatures

Very often weather reports include the high and low temperatures for a twenty-four hour period. Perhaps you have relayed this type of report to your classmates during current events or weather studies in the past. Do you think that the meteorologist who recorded this information waited outdoors beside a thermometer to note the high and low temperature readings for twenty-four hours? Not likely! Instead, a different type of thermometer, called a *maximum-minimum thermometer,* was probably used. This instrument records the maximum or highest temperature and the minimum or the lowest temperature of an area for a period of time. Although you may not have a maximum-minimum thermometer, it is a fairly common and inexpensive instrument. You will probably be able to borrow this device from a high school or senior elementary school science teacher. Try to obtain one or more of these thermometers for the following study.

Several points must be observed when using a maximum-minimum thermometer. Sometimes the mercury or coloured alcohol in the columns is separated. By firmly grasping the thermometer in one hand, raising it to your shoulder level and moving your arm to-



What is the purpose of the blue marker in each column?

ward the ground in several quick up and down motions, you will be able to correct this defect.

The thermometers should register the same temperatures if they are in the same place. To ensure that they do, you should standardize the thermometers. This can be done by placing the thermometers on a table and allowing the mercury or alcohol to settle. Read the temperatures. If there is any difference, then mark on a piece of tape the number of degrees that must be added or subtracted to each thermometer so that they will all be the same. Attach the tape to the thermometer.

In each column there are magnetic markers or indices which should be moved to the height of mercury or coloured alcohol with the small magnet that is provided. This should be done when you place the maximum-minimum thermometer in the area that you have decided to test. The small magnet is easy to lose, so keep it in a safe place.

The maximum-minimum thermometer should be left in one place for a long period of time, such as twenty-four hours. When you revisit the area to record the temperatures, try not to move the thermometer. Read the maximum and minimum temperatures at the bottom of each index.

A weather report usually states one maximum and one minimum temperature in an area like a city for one day. However, there are often wide temperature differences in small areas, such as around your school, that might differ from the readings of the weather bureau.

When should the indices be set with the magnet?

Activity 11 will guide you in discovering the coldest and warmest locations around your home and school area.

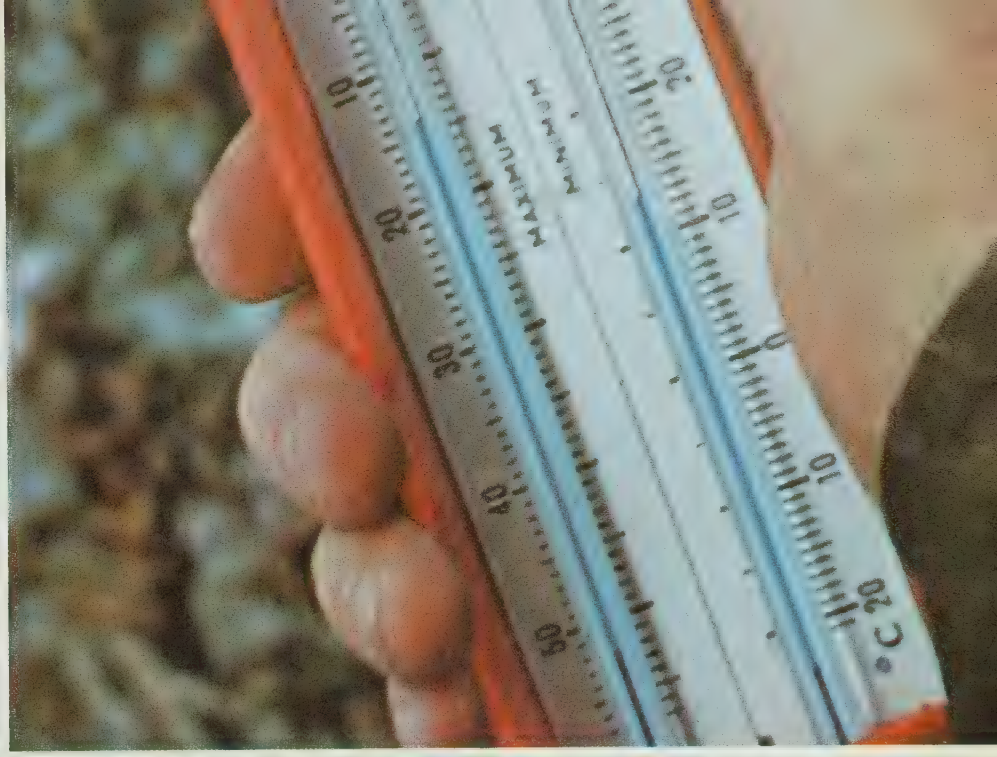
Activity 11:

How do the maximum and minimum temperatures vary in several outdoor areas over a twenty-four hour period?

Make sure that you read the instructions carefully and learn how to use a maximum-minimum thermometer before you begin this activity.

Choose several locations in your backyard where you would like to record the high and low temperatures for twenty-four hours. The number of areas that

This maximum-minimum thermometer has been left outside overnight. What were the maximum and minimum temperatures?



Beside a building.

you test will depend upon how many maximum-minimum thermometers you have.

It is important that you leave the thermometers in places where they will not be damaged, lost, or stolen.

Leave the maximum-minimum thermometers in each area for twenty-four hours.

On the next day, return to each area, and record the data shown on the thermometers in a field record.

Transfer your information to a chart similar to the one shown.

Under an evergreen tree.

The Maximum and Minimum Temperature in My Backyard

Description of the Area	Date and Starting Time	Date and Stopping Time	Maximum Temperature	Minimum Temperature
1. Tied to the Trunk of a Tree (north side)	16:30 Jan. 21	16:30 Jan. 22	– 4°c	-12°c

Digging Deeper

Were the maximum and minimum temperatures the same in any of the areas?

In which area was the highest maximum temperature? lowest maximum temperature? highest minimum temperature? lowest minimum temperature?

What was the range of maximum temperatures? minimum temperatures?

What was the average maximum temperature? minimum temperature?

In which area did you observe the greatest range between the maximum and minimum temperatures? the least range? Why?

How do you account for the difference in maximum temperatures? minimum temperatures?

How do your maximum and minimum readings compare to the high and low temperatures recorded by the local weather bureau for the same time period?

What differences in maximum and minimum temperatures would be found in the following areas: under a deciduous and an evergreen tree, from ground level at 25 cm intervals to 1 m above the ground, in a frozen pond and a running stream, on a grassy lawn and a concrete sidewalk or patio. Be certain that the only variable is the area where the thermometers are placed. Every other factor in your investigation should remain the same.

Winter Scenes

One of the purposes of this book has not only been to encourage you to study nature in the outdoors during winter but also to appreciate just how fortunate we are to live in a part of the world that experiences vast differences in its seasons. Winter provides us with a wonderful opportunity to be outdoors. Artists have used winter scenes as some of their favourite subjects for their masterpieces. The following activity will encourage you to apply your artistic talents out-of-doors.

Activity 12:

How can winter scenes be sketched in the out-of-doors?

Collect a sketching board (a piece of hardboard about 50 cm by 70 cm), coloured pieces of folding paper or manilla paper (30 cm by 45 cm), and a charcoal stick or coloured chalk. Secure the paper to the sketching board with an elastic band, clothes pins or paper clips.

You can easily make a viewing frame that will help you define and sketch a winter scene. Cut a piece of Bristol board to make a shape 15 cm by 10 cm. Cut a section that is 10 cm by 5 cm from the middle of the Bristol board so that it becomes a frame with a 3 cm border and a rectangular opening in the centre.

Find a suitable outdoor setting with interesting subjects to sketch.

The advice of friendly critics is always helpful.

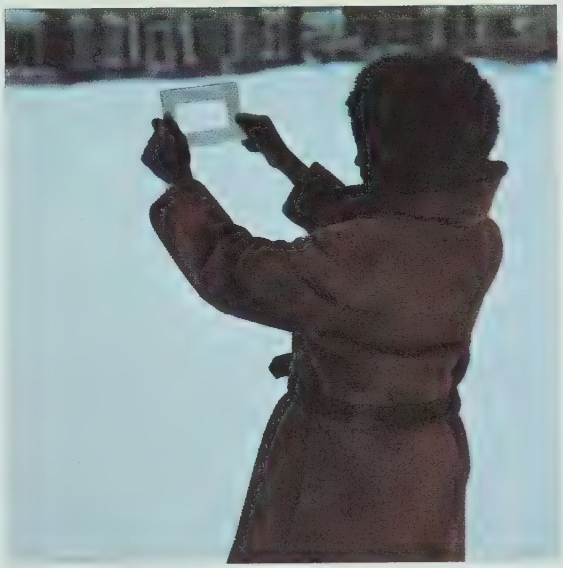
Decide on a scene that is near to you or at a distance. Use your viewing card to frame a good scene in your line of sight. Move the frame toward your eyes or farther away until you find the exact position where the complete scene that you want to sketch is inside the frame, like a picture.

Before you sketch what you see inside the viewing frame, you might consider the following suggestions.

Sketch only what is inside the viewing frame.

Note where the horizon is in the viewing frame and sketch it on your paper.

What will happen as Rosalind moves the viewing frame closer to her eyes?



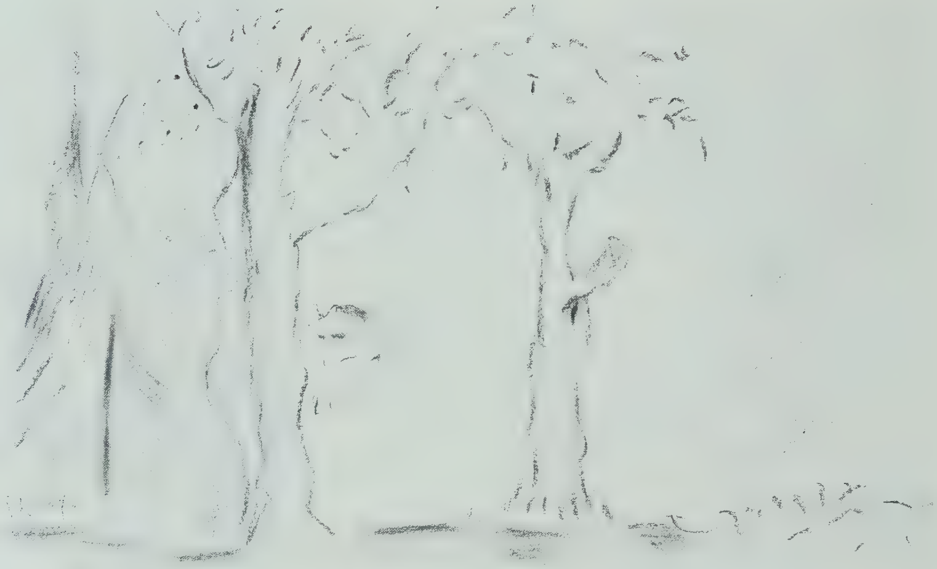
Sometimes it is best to be alone to capture the mood of the scene.

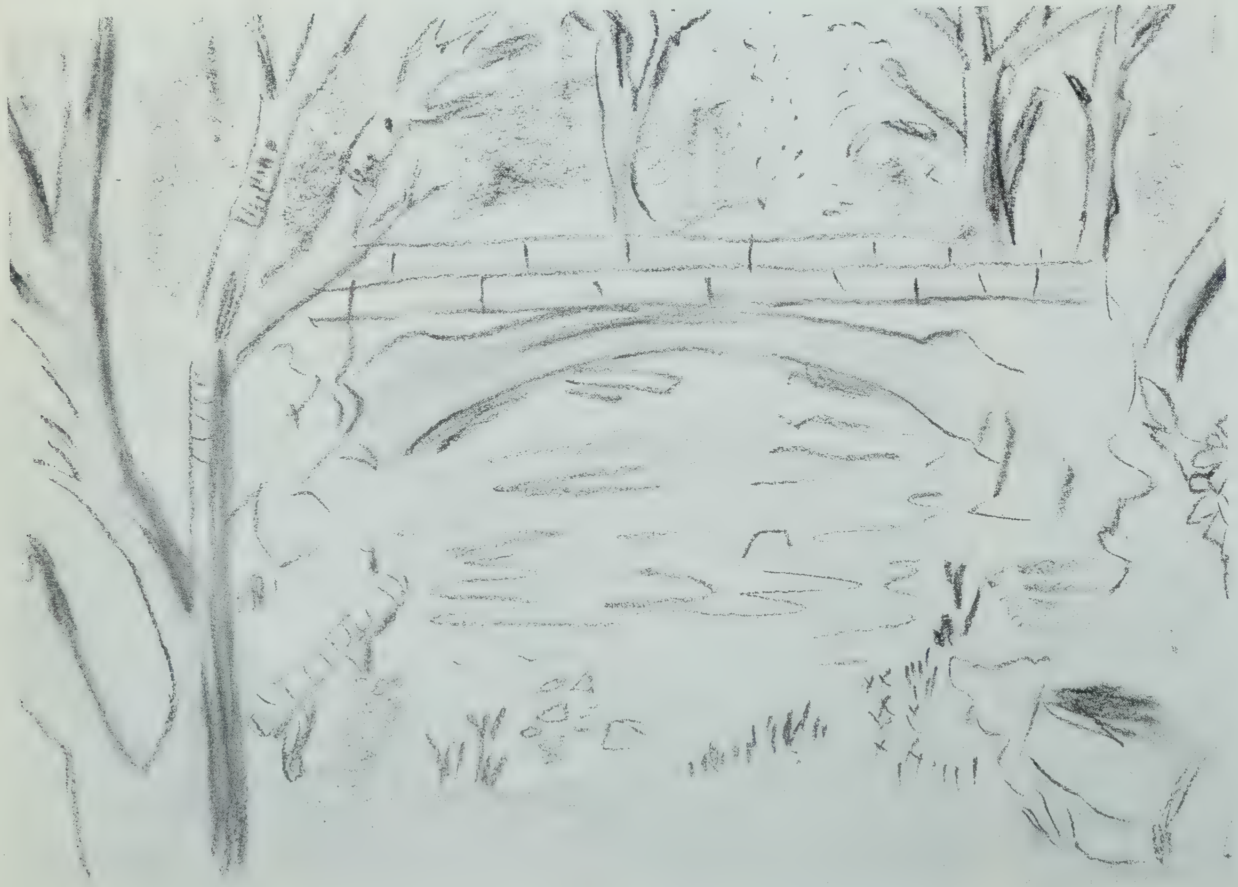
What media did you decide to use?

Decide which objects are in the foreground, middle ground, and background in the viewing frame and space them accordingly when you sketch them on the paper. The sides of the frame will help you to judge how to space these objects on your picture.

Observe the size of the objects that are close and far away in the frame, and sketch the same differences in size on your paper.

A picture contains many different kinds of lines such as thick, narrow, long, short, curved, straight, etc. Try to make good use of a variety of lines in your sketch.





What do you like about these pupils' sketches? How would you improve them?

Carol decided to write a poem about the frozen stream after she finished her sketch.

You might require several attempts to perfect your sketching technique.

Try to use different media and subjects in your sketchings. Your works of art will make an attractive display in your classroom.

Branching Out

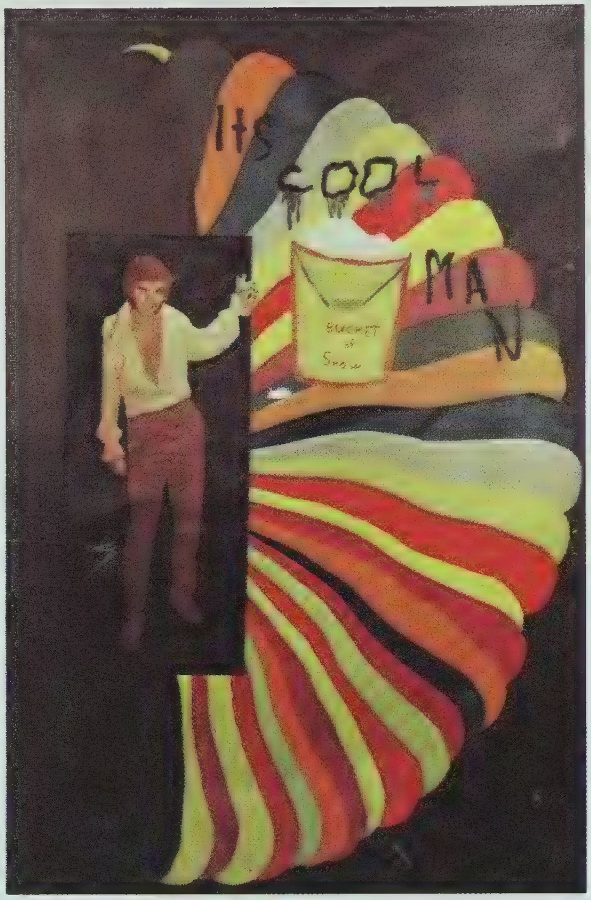
How can winter subjects be used for poster making?

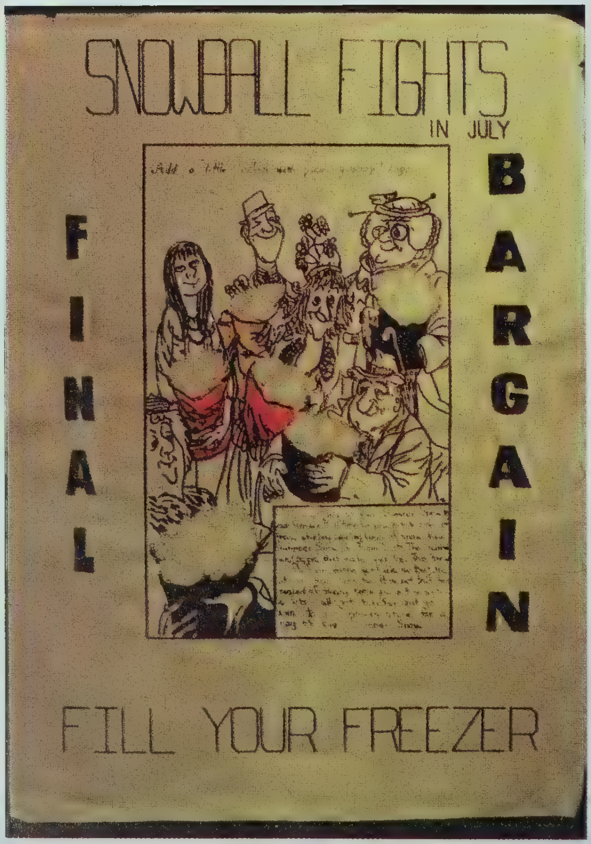
Posters are effective means of communicating messages. There are certain rules and techniques that govern how a good poster should be made.

Study the following posters made by students to learn their techniques and how well they have conveyed their messages.

Choose an interesting topic and make a poster that will convey your message. You might decide on a humorous theme or a more serious one.

Some topics might be: winter in July and August, winter all year long, summer all year long, protect winter wild life, save our coniferous trees from Christmas cutting, safety with snow vehicles, winter is for outdoor activities, winter dangers.





How well did the students convey their message in each of these posters?

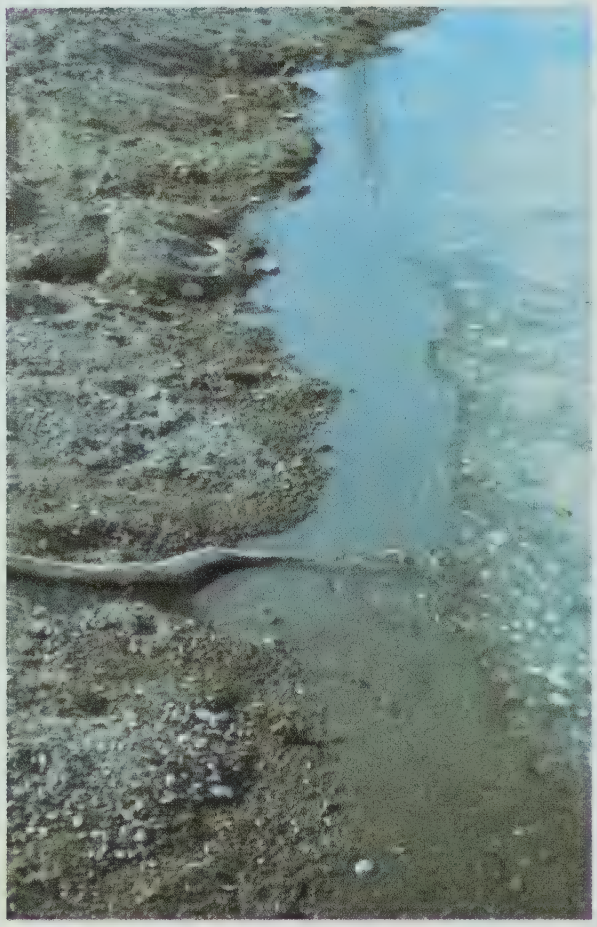
Thoughts About Thaws

4

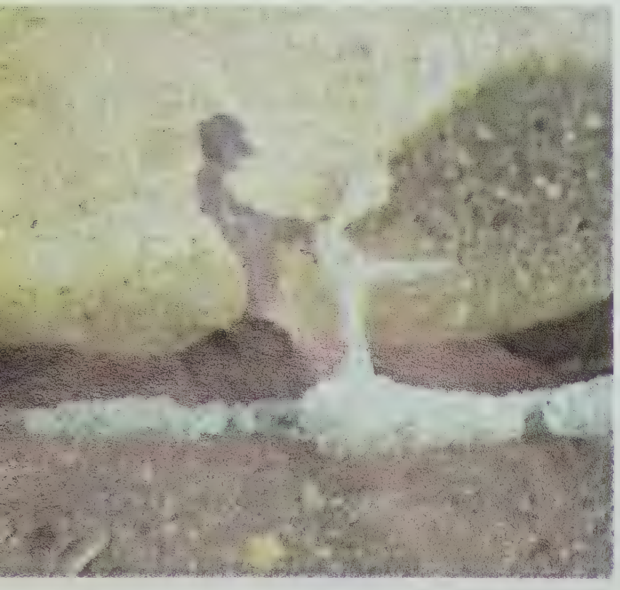
4. Thoughts about Thaws

Usually the maximum and minimum temperatures for a winter day are below the freezing point. As the spring season approaches, however, the maximum temperature during the day begins to climb above the freezing point, yet the minimum temperature during the night remains below freezing. There seems to be a race between the winter freezing elements and the spring thawing elements. At first, one is ahead and then the other until the weather conditions produce a clear-cut verdict. Sometimes such a battle is even waged during a midwinter thaw. This melting and freezing cycle produces many interesting phenomena in the most unlikely places. Examine the following photographs carefully and suggest solutions to the problems posed.

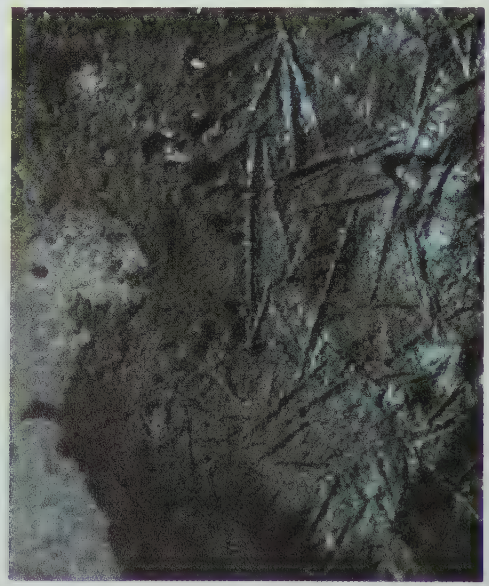
Why does melting occur at the edges of a pond first?



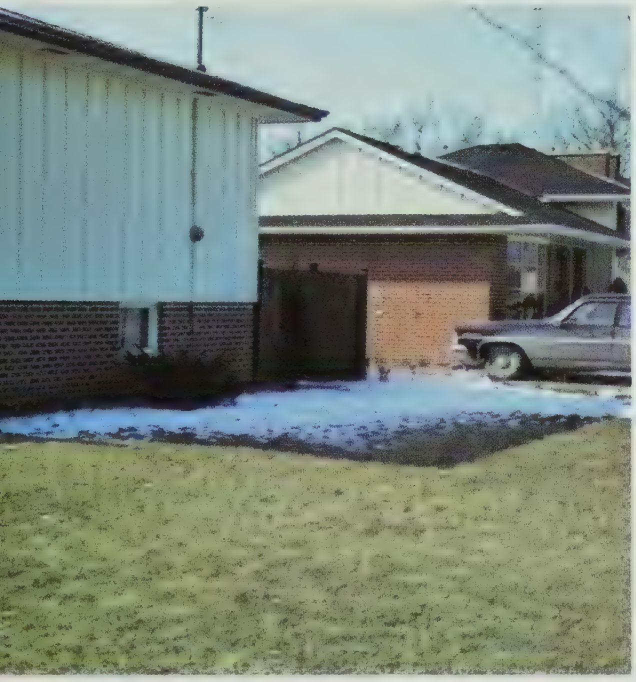
Use your imagination to create a short story to describe what has happened to cause such an unusual figure of snow between the sections of a sidewalk.



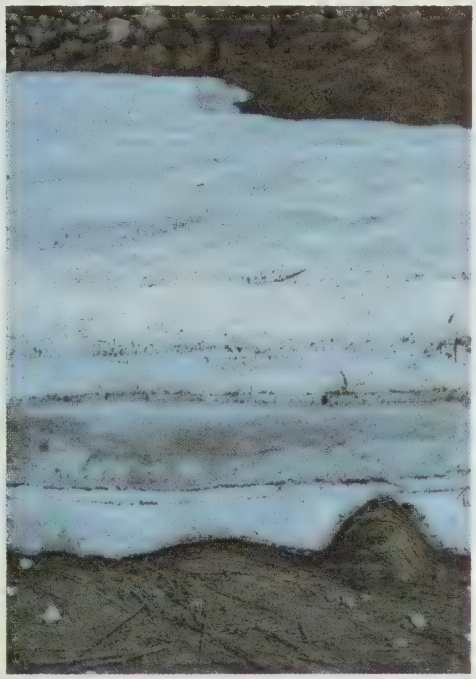
How did ice cause the lines in the mud beside the pond?



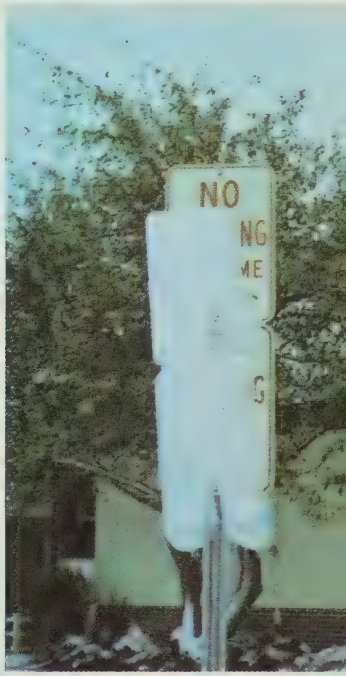
Explain the pattern of snow melting on this lawn.

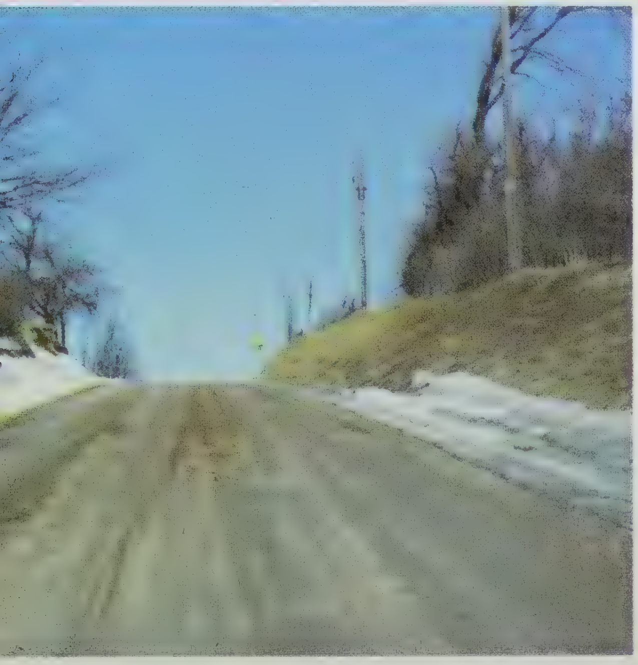


This is a snowbank that seems to be a mini-glacier. What evidence can you see that shows how glaciers wear down and rearrange the earth's surface?

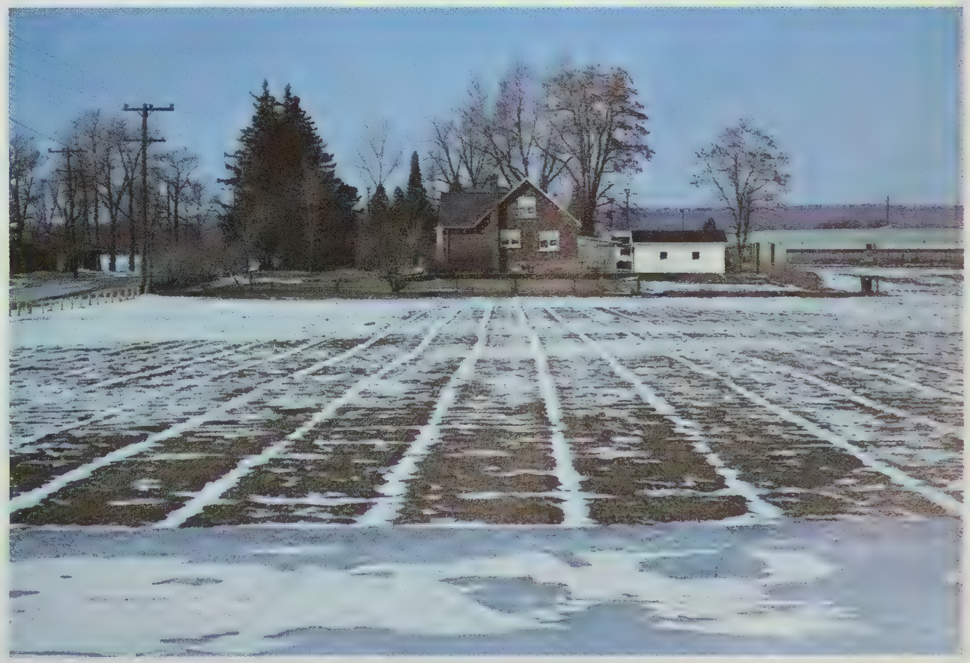


Why has the snow slipped on this parking sign?



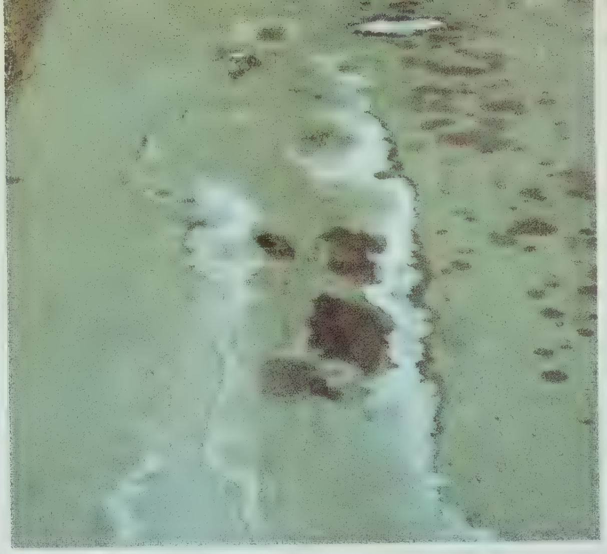


Why is there much more snow on the left side of the road and very little snow on the right?

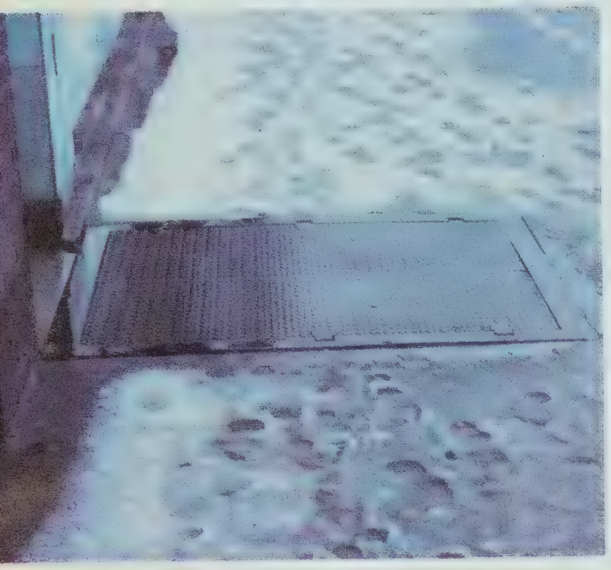


How would you account for the pattern of snow melting in this field?

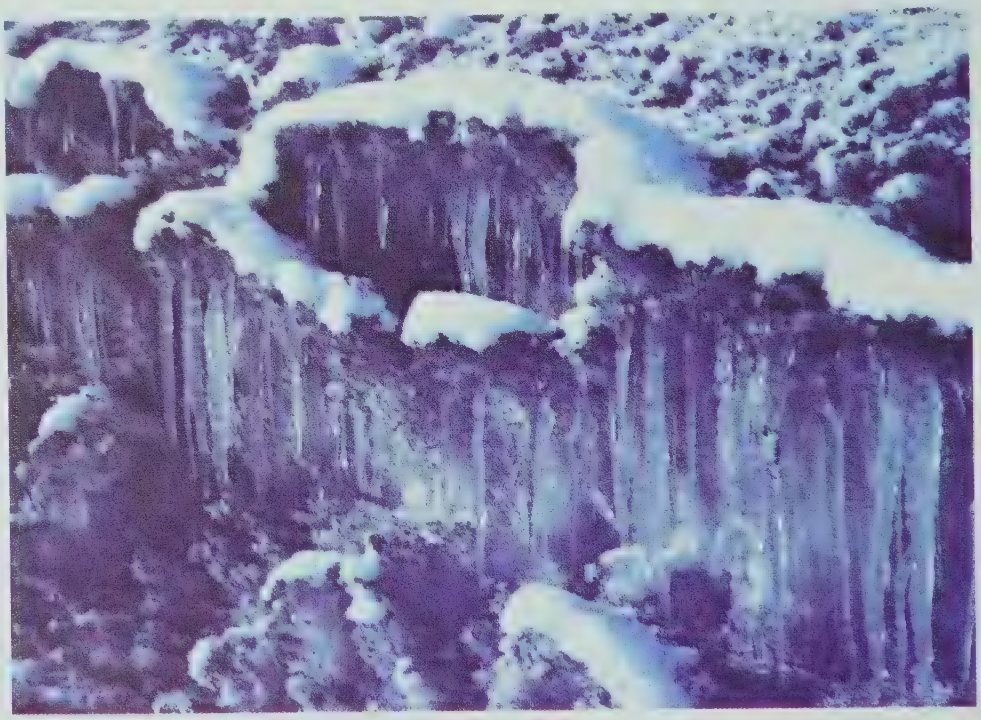
The white material on the driveway is not snow, yet, it was left after the snow melted. What is the white matter and what caused its formation on the driveway?



Why did melting occur on the steel doors before the sidewalk?



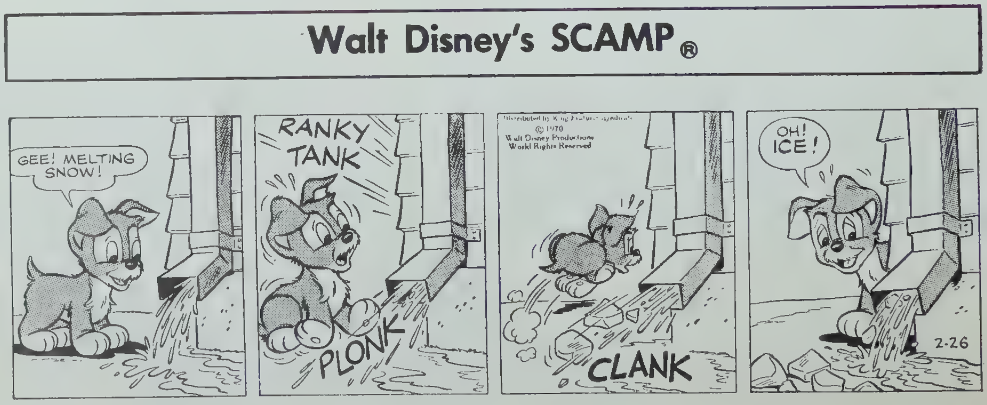
How would you explain some of the different aspects of snow and ice in this photograph?



Collect your own series of photographs during a winter or spring thaw. Think of appropriate captions that can be attached to the photographs and present your project puzzles to your classmates.

You have probably noticed from your own experience and from the photographs at the beginning of this chapter that snow and ice melt at different rates. Even when we think that we have seen the last of the winter snow, we sometimes discover traces of snow and ice in the most unexpected places.

The pieces of ice in the melt water took Scamp by surprise as they rattled down the spout of the eavestrough. Does snow always melt before ice? Where does melting occur first and last around your home?



Melting Snow

It is obvious by now that many factors affect the melting of snow and ice. One factor that you have probably recognized is the colour of snow and the colour of surfaces on which snow and ice can be found. Some colours absorb solar or sun energy (in the forms of light and heat) better than others. Others reflect this light and heat energy readily. You can conduct a simple experiment out-of-doors to find which colours absorb and reflect solar energy most efficiently.

Activity 1:

How is the rate of melting affected by the colour of snow?

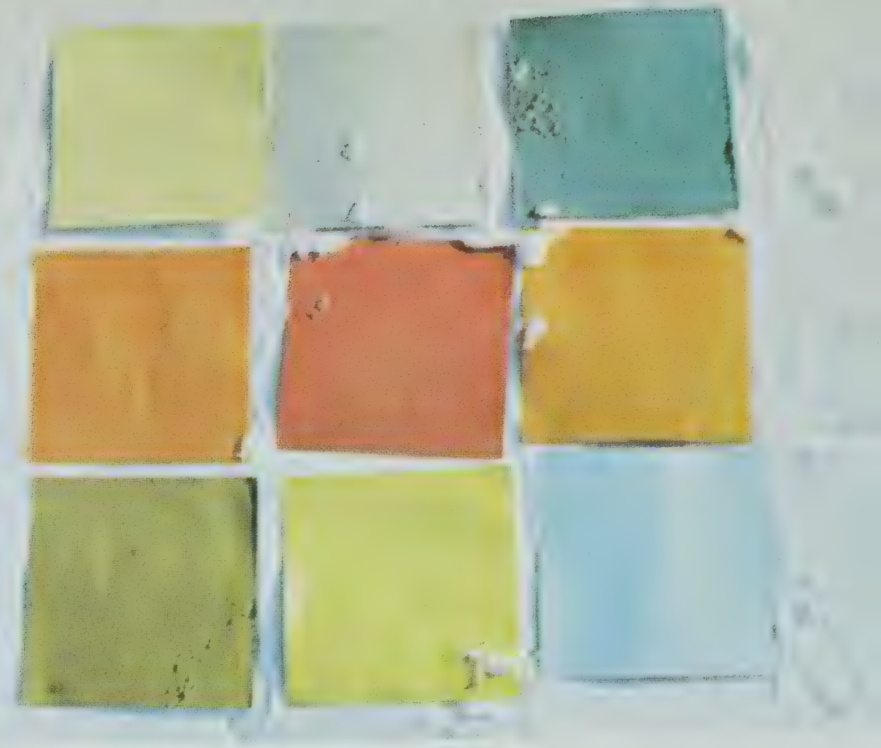
Collect five old salt shakers and fill each with a different colour of tempera powder. Make sure that you have a variety of light and dark colours. On a calm, sunny, winter day find a flat open area where the snow is the same depth and evenly distributed. Mark off five plots that are each 30 cm square. Record the snow temperature at the surface in each plot. Sprinkle a different colour of tempera powder evenly onto each plot.

Why should care be taken to sprinkle the same amount of tempera powder on each plot?

Leave the plots undisturbed in the bright sunlight for 3 h, or as long as possible.

When you return to your plots, record the snow temperature at the surface of each section. Compare the evidence of melting that has occurred in each plot. List the colours in order of the most melting to the least melting.

Predict the order of colours under which snow will melt, first to last.



Digging Deeper

Under which colour did the most melting of snow occur? the least melting?

In which plots did the temperature change during the experiment?

In which plot was there the greatest change in temperature?

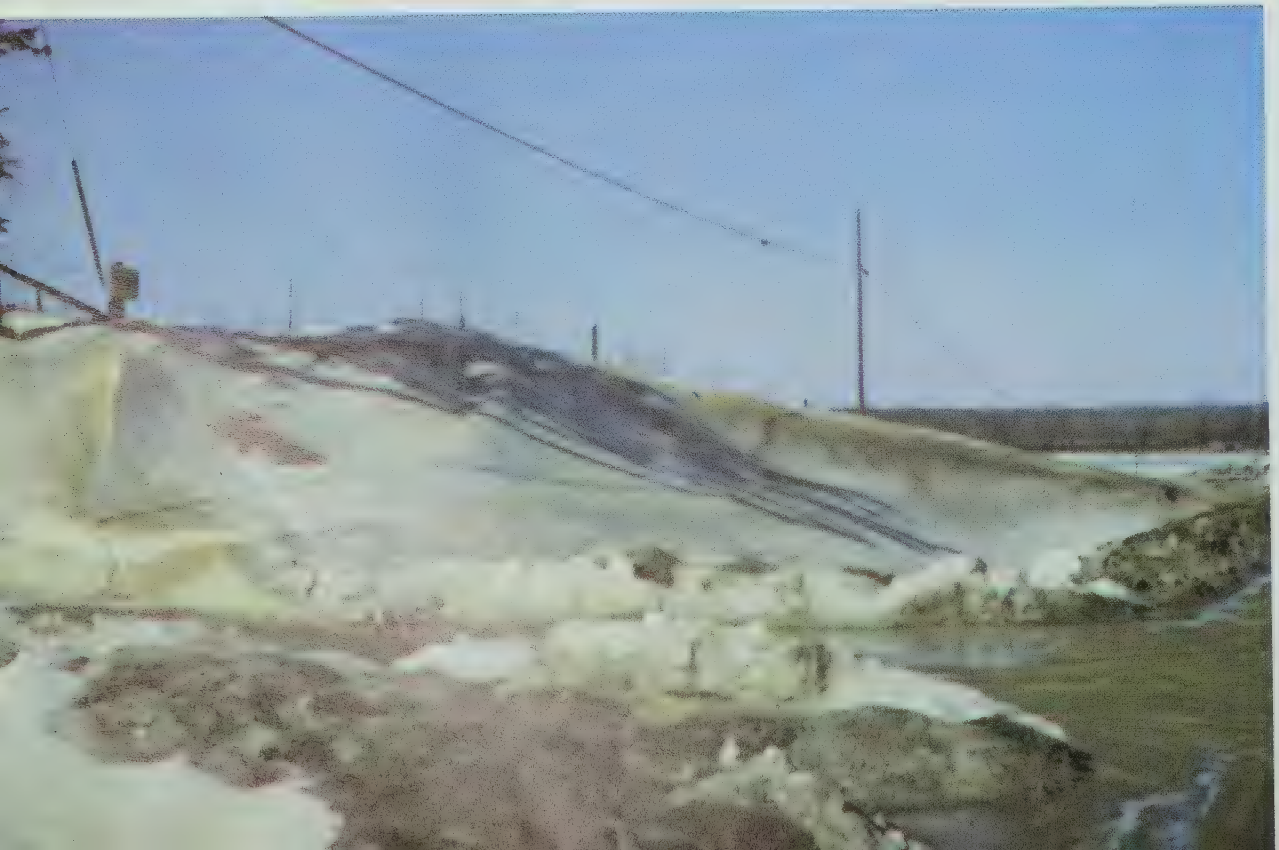
List in order the temperature readings for each plot from the greatest increase to the least increase. How does this list compare to your ordered list of plots that showed the greatest melting to the least melting?

Describe the ability of each colour to absorb or reflect sunlight?

Which colour absorbed the most sunlight?

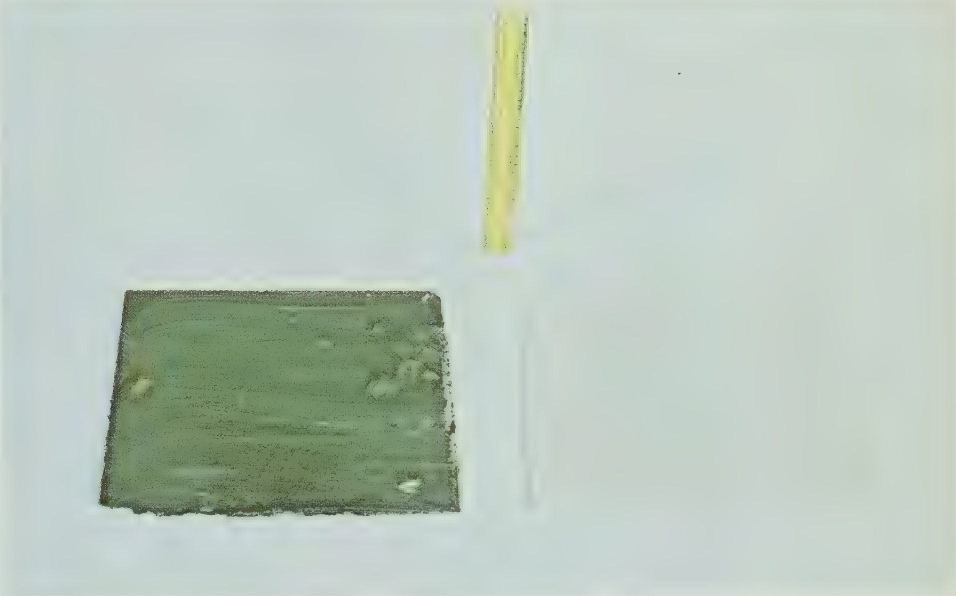
Which colour reflected the most sunlight?

Leaf through the pages of this book, and examine the photographs for the colour of clothing worn by students outdoors. What colours are the most common? Why?



Where will the melting of snow occur first on this snowbank? Why?

Why do these leaves appear to have sunk in the snow?



These two types of floor tile were placed on snow during a sunny period. On the following day Kimmie measured the depth that each tile had sunk into the snow. What factors would cause differences in the depths?

Activity 1 (a):

At what rates will different light objects melt snow?

Repeat Activity 1, but instead of using tempera powder, place various common objects on the snow. You might use: floor tiles, sand, sawdust, flour, iron filings (cut up some steel wool), sugar, wood chips, salt, leaves, different types of paper, tarpaper, aluminum foil, pieces of fabric or carpet.

Return to the plots on the following day, and measure the distance that each material melted into the snow.

Record your results on a graph.

Digging Deeper

Which materials had settled most deeply into the snow? least deeply?

List as many factors as you can that might have affected the ability of the objects to melt the snow.

Experiments to test the melting rate of snow can be better controlled by studying the melting of snowballs.

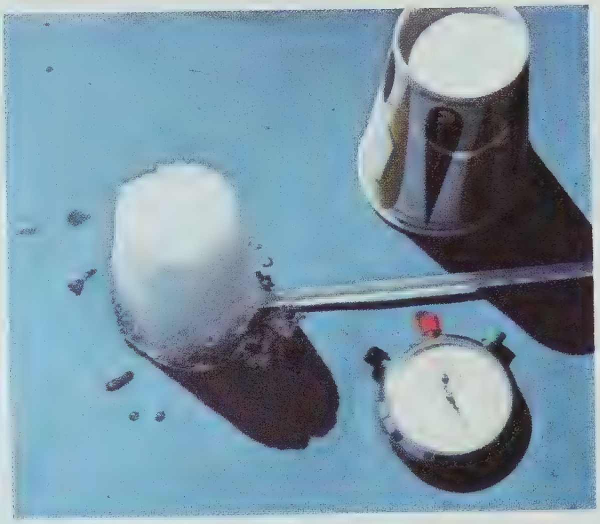
Activity 2:

How do the surfaces on which snowballs are placed affect the rate of melting?

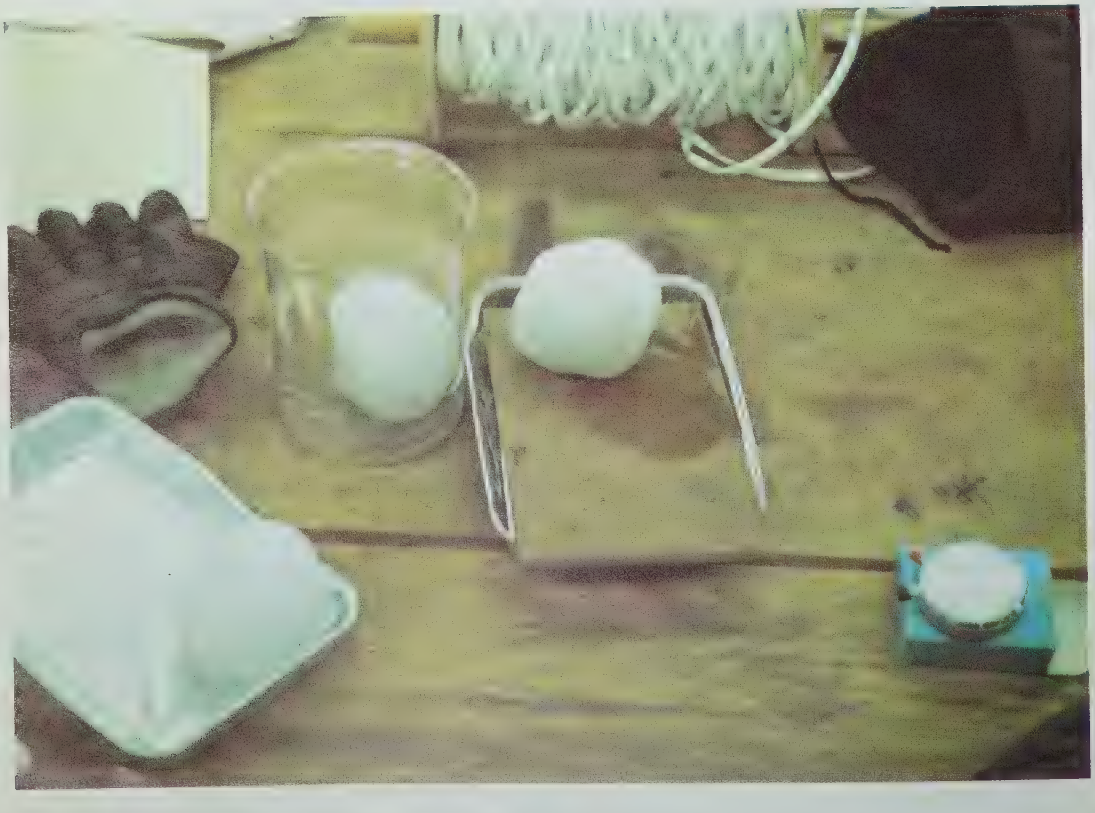
This activity could best be performed with a large number of students, perhaps a whole class. Each small group of two students would be responsible for preparing two surfaces on which snow can be placed and conducting the experiment. Each surface should be approximately 30 cm square. They might include some of the following: different types of floor tile, ceramic tile, cement, carpeting, glass, tin, tinfoil, soil, tarpaper, peat moss, cardboard, wood, styrofoam, coal, ceiling tile, rubber mat, shingle, plastic sheet, ashes, sandpaper, salt crystals, insulation, sawdust, gravel, cork, straw.

Use your imagination to think of other surfaces that could be used.

Predict the surface on which you think that a snowball will melt the fastest.



In which photograph have the snowballs been made more scientifically for this experiment?



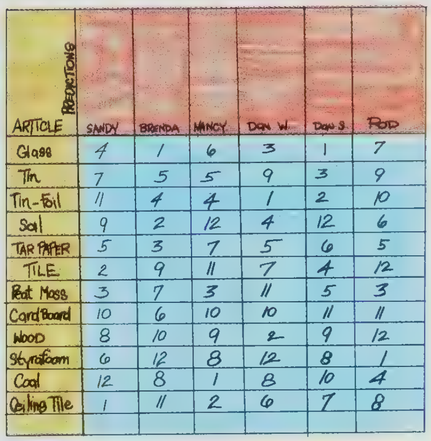
Number all of the surfaces in the order that you think that melting will be completed.

The snowballs must be of equal size.

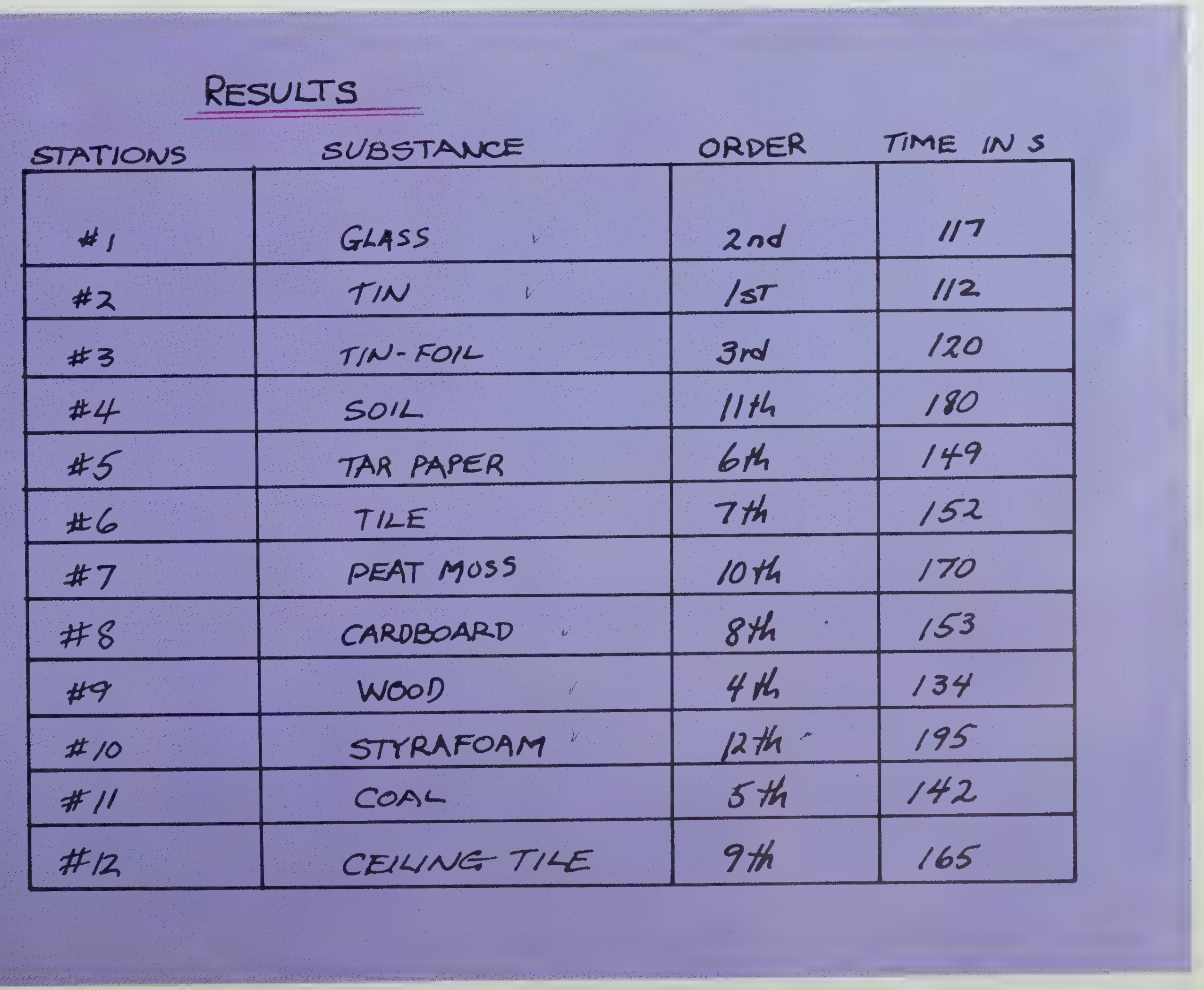
Place a snowball or small container of snow on each surface at the same time.

Use a watch to measure the length of time required for the snow to completely melt on each surface.

Record your information on a chart.



ARTICLE PREDICTIONS	SANDY	BRENDA	NANCY	DON W.	DON S.	ROD
Glass	4	1	6	3	1	7
Tin	7	5	5	9	3	9
Tin-Foil	11	4	4	1	2	10
Soil	9	2	12	4	12	6
TAR PAPER	5	3	7	5	6	5
TILE	2	9	11	7	4	12
Peat Moss	3	7	3	11	5	3
CardBoard	10	6	10	10	11	11
WOOD	8	10	9	2	9	12
Styrafoam	6	12	8	12	8	1
Coal	12	8	1	8	10	4
Ceiling Tile	1	11	2	6	7	8



RESULTS

STATIONS	SUBSTANCE	ORDER	TIME IN S
#1	GLASS	2nd	117
#2	TIN	1st	112
#3	TIN-FOIL	3rd	120
#4	SOIL	11th	180
#5	TAR PAPER	6th	149
#6	TILE	7th	152
#7	PEAT MOSS	10th	170
#8	CARDBOARD	8th	153
#9	WOOD	4th	134
#10	STYRAFOAM	12th	195
#11	COAL	5th	142
#12	CEILING TILE	9th	165

How accurate were your predictions?

You might like to record the results of your experiment by making a diagram of the surfaces that you tested.

Digging Deeper

What was the only factor that changed in this experiment?

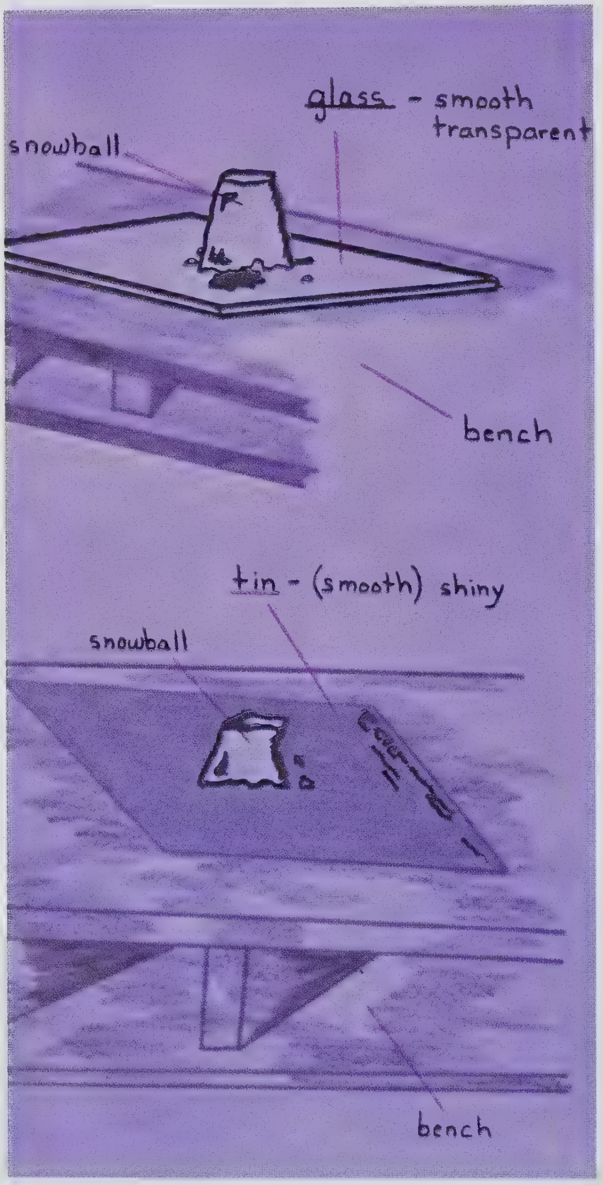
How were the other factors that might have affected the results of this activity controlled?

On which surface did the snow melt the fastest? the slowest?

From your records, describe how the following types of surfaces affected the rate of melting: shiny and dull surfaces, light coloured and dark coloured surfaces, smooth and rough surfaces, thick and thin surfaces, hard and soft surfaces.

What are the factors that enable some surfaces to absorb more heat than others?

According to the results discovered by the students who made the records on page 71, the tin surface promoted a greater rate of melting than the styrofoam surface. What differences in these surfaces would cause the different rates of melting?



How did the characteristics of the surfaces described in the photograph affect the rates of melting?

One student recorded her activity in the form of a poem.

An Unusual Job

We filled the paper cups with snow,
Then emptied them all out,
To see how fast the snow would melt
And what this job's about.

At eleven o'clock the race was on
Though it progressed quite slowly,
All of us patiently waited around,
We should have played Rumoli.

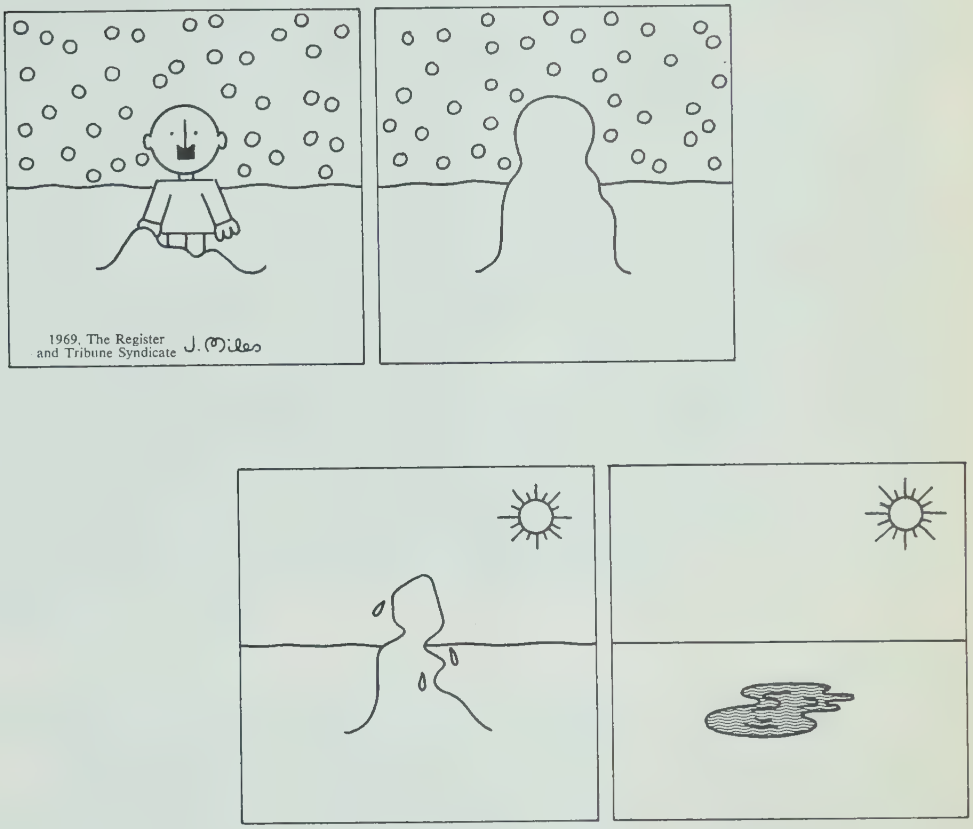
By 12 o'clock, 'twas plain to see
First place the tin would claim,
All of us guessed the glass would be next,
'Twas fun to play this game.

Tin foil was next and then the wood,
With coal right close behind,
It was not hard to tell by now,
The loser we could find.

At last the styrofoam came in
The time was three fifteen,
And now, where all the snow had sat
A puddle could be seen.

by: Nancy Haight

Can you record your activity in cartoon form?



1969, The Register and Tribune Syndicate J. Miles

How did the colour of the snow change as the experiment progressed?

Activity 3:

How does the temperature of snow change as it melts?

Place a small amount of snow on a surface. Record its temperature every 3 min until it has completely melted.

Transfer your data to a graph similar to the one shown on the next page.

Digging Deeper

At what temperature did drops of melt water first appear?

At what temperature did the last trace of snow disappear?

What was the range of temperatures measured?

Describe the temperature pattern as the snow melted.

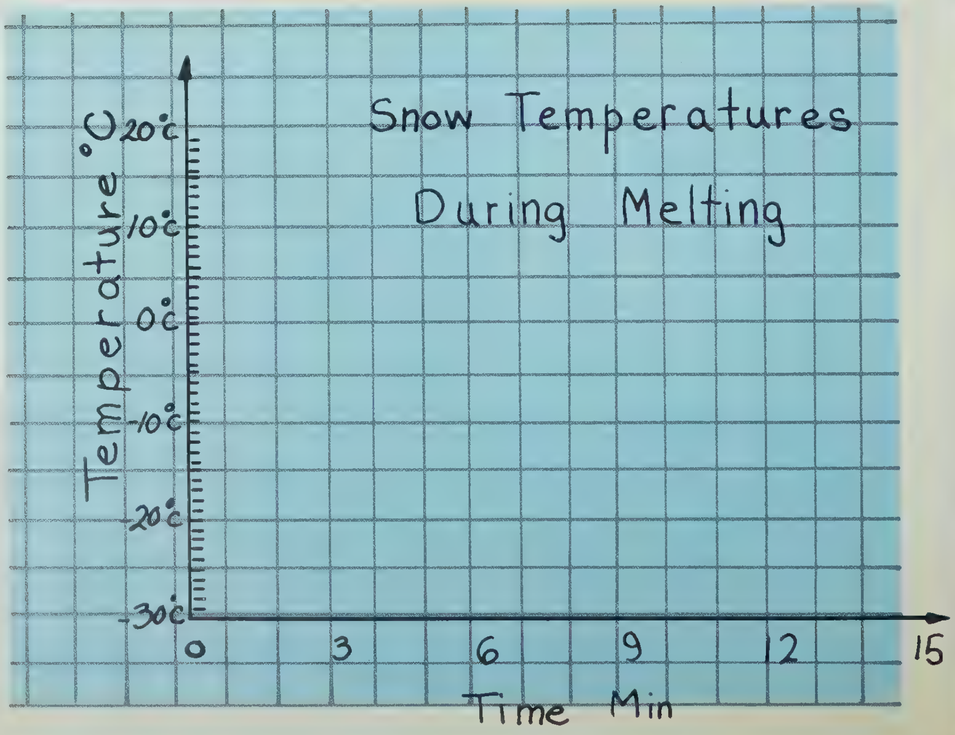
What was the temperature at the 5 min mark? (Hint: Use your graph to find the answer.)

What would the temperature have been 3 min after the snow was completely melted?

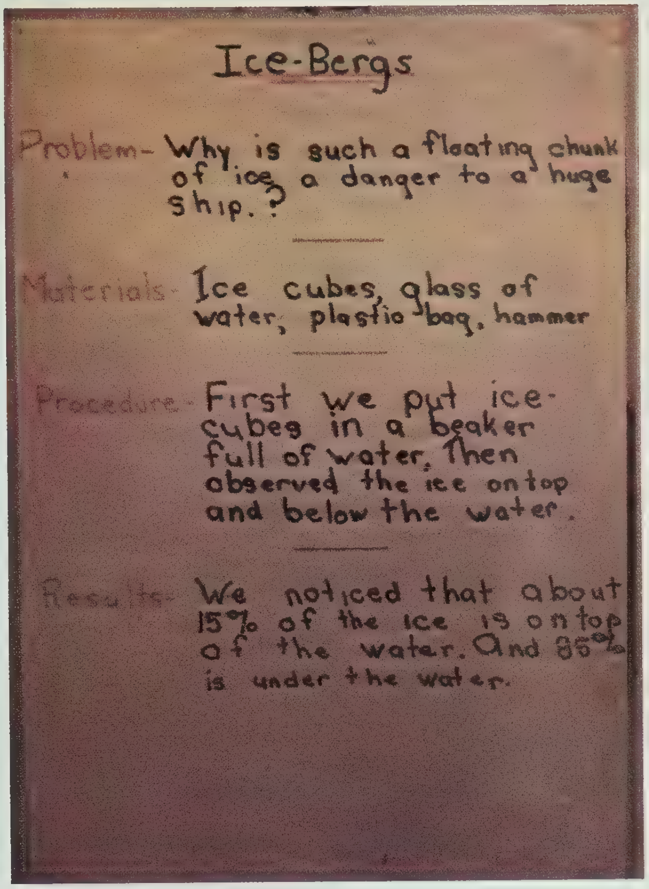
One of the most interesting aspects of melting ice in nature is the formation of icebergs. You can improvise icebergs in your classroom and perform an experiment to find out more about floating masses of ice.

What could you do to this giant snowball to prevent it from melting quickly?

Would an aluminum pie plate be a better surface to use than construction paper? Why?



This record shows that the students performed the same experiment but in a different way. How do their results compare with yours?



Ice-Bergs

Problem- Why is such a floating chunk of ice a danger to a huge ship.?

Materials- Ice cubes, glass of water, plastic bag, hammer

Procedure- First we put ice-cubes in a beaker full of water. Then observed the ice on top and below the water.

Results- We noticed that about 15% of the ice is on top of the water. And 85% is under the water.

Activity 4:

How much of an iceberg is submerged?

Find a piece of ice at least 15 cm thick in a pond that is melting, or make one in your freezer. You might decide to purchase a block of ice from an ice-vending machine.

Cut the block of ice so that it will fit into a large aquarium.

Fill the aquarium with water, so that the top of your iceberg is even with the top of the aquarium.

Measure the height of the ice above the water surface and the depth of the ice that is underwater. Record your information.

Digging Deeper

What fraction or percentage of the ice was above the water level in your experiment? below the water level?

How would the results of the experiment differ if salt water was used rather than the fresh water that you probably used?

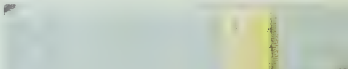
Why are icebergs considered to be dangerous to navigation?

Read accounts of the sinking of the Titanic to find out how dangerous icebergs can be.

What do ships use today to avoid dangerous icebergs?

How do you think that this small iceberg broke away from a larger bank of ice?

How much more ice is below the water than above it?



Icebergs are very mobile. As they travel, they are affected by the temperatures of the water and air around them. Consequently, in the far north they remain intact, and in warmer climates, they begin to melt.

Scientists keep careful observations on the movement of icebergs. In this way, they not only aid shipping, but also learn more about ocean currents.

The following activity will guide you to investigate water currents caused by ice.

Activity 5:

What water currents are caused by melting ice?

Freeze an ice cube tray of coloured water. Use a dark colour.

Fill a wide-mouth 5ℓ jar or an aquarium with tap water at room temperature to approximately 0.75 full.

Allow the container of water to sit undisturbed until the water is very calm.

Carefully place a coloured ice cube in the water at one side of the container.

Observe what happens and make sketches of your observations.

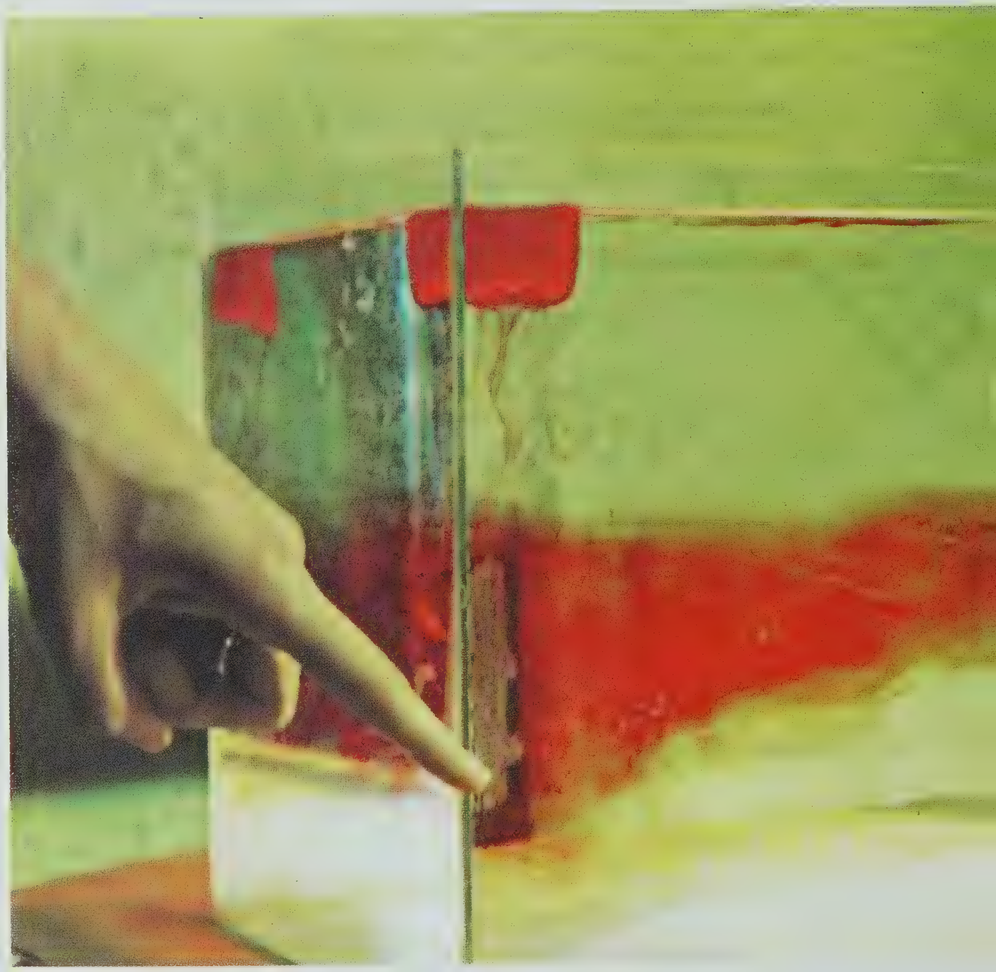
Digging Deeper

Describe the path of the water current produced by the melting ice cube.

What caused the water current to sink?

If cold water sinks why does ice float?

Pat is observing the pattern of the water currents.



If deep lakes froze from the bottom up, would they completely melt in the summer?

Branching Out

Repeat Activity 5 and place several thermometers at intervals in the coloured current.

Record any differences in the temperature readings.

What is the Gulf Stream? How do warm and cold currents in the ocean affect land masses?

Slip and Slide

5

5. Slip and Slide

The fact that snow and ice are slippery provides us with a multitude of winter activities. Have you ever had the opportunity to enjoy skating, curling, skiing, hockey, tobogganing, sledding, ice boating, snowmobiling, or even just sliding on a slippery patch of ice? In some countries and regions, the climate is such, that much of the transportation is based on moving heavy loads over slippery surfaces. In these places, a winter sport becomes a way of life. However, slippery ice and snow make travelling very treacherous. The following photographs illustrate some of the slippery aspects of snow and ice.

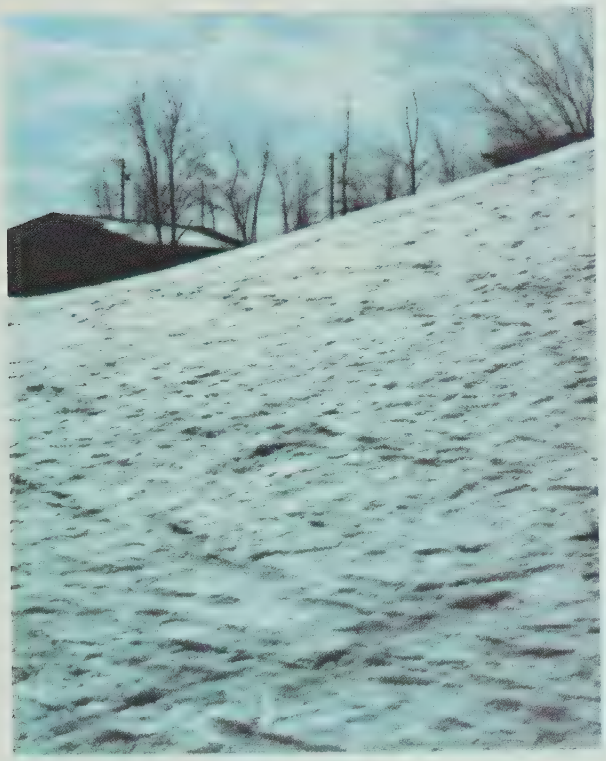
Would you slide across the ice on this pond? Explain your answer.

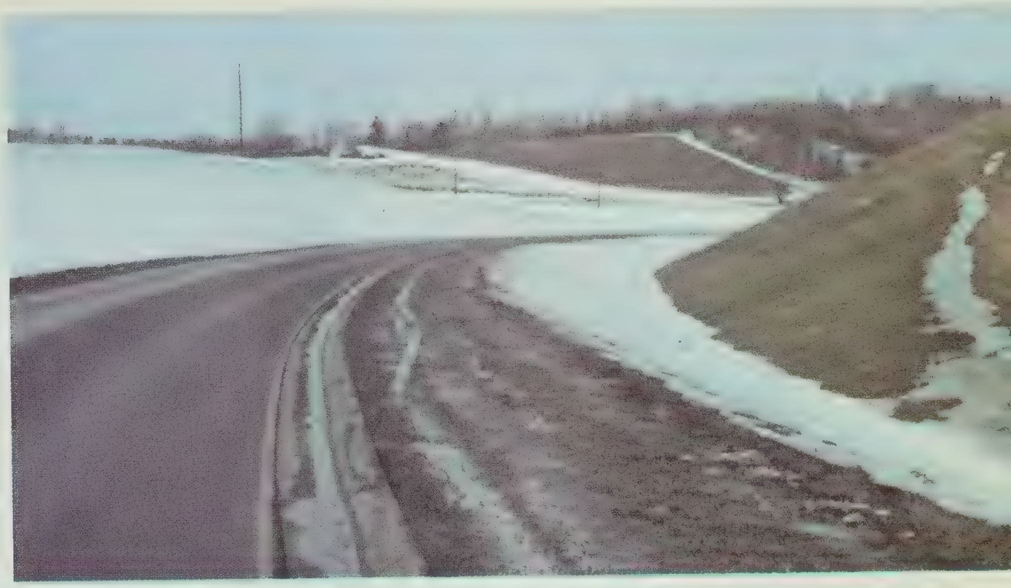
Why do some schools forbid this type of activity on the playground?

How is this snow vehicle equipped to ride on top of the snow?

If you were going to build a toboggan or ski run, on which side of a hill would you make it? Why?

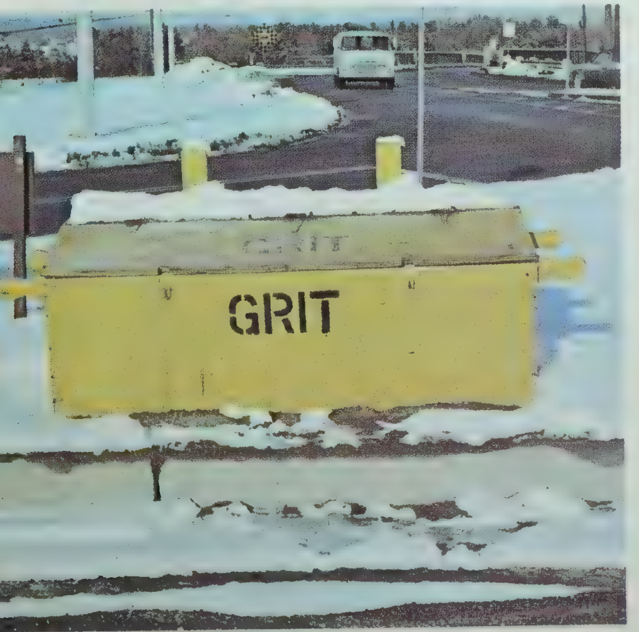
Would this hill make a good toboggan or ski run? Explain your answer.





Why are hockey pucks frozen before professional hockey games?

How would the contents of the yellow box in the photograph on the left help the driver in the photograph on the right?



Activity 1:

How slippery is ice and snow?

Tie a piece of strong string approximately 1 m long to a brick and attach a spring scale to the other end of the string.

A spring scale is a device that is used to find mass. Sometimes fishermen use fish scales (spring scales) to find the mass of the fish that they have caught. The hook at the bottom of the spring scale is placed under a fish's gill covering and the scale is lifted so that the fish is hanging in the air. The mass of the fish pulls down on a spring inside the scale and a marker points to a number on the scale to show what the mass of the fish is. A scale can also be used to measure the amount of force needed to pull an object along the ground.

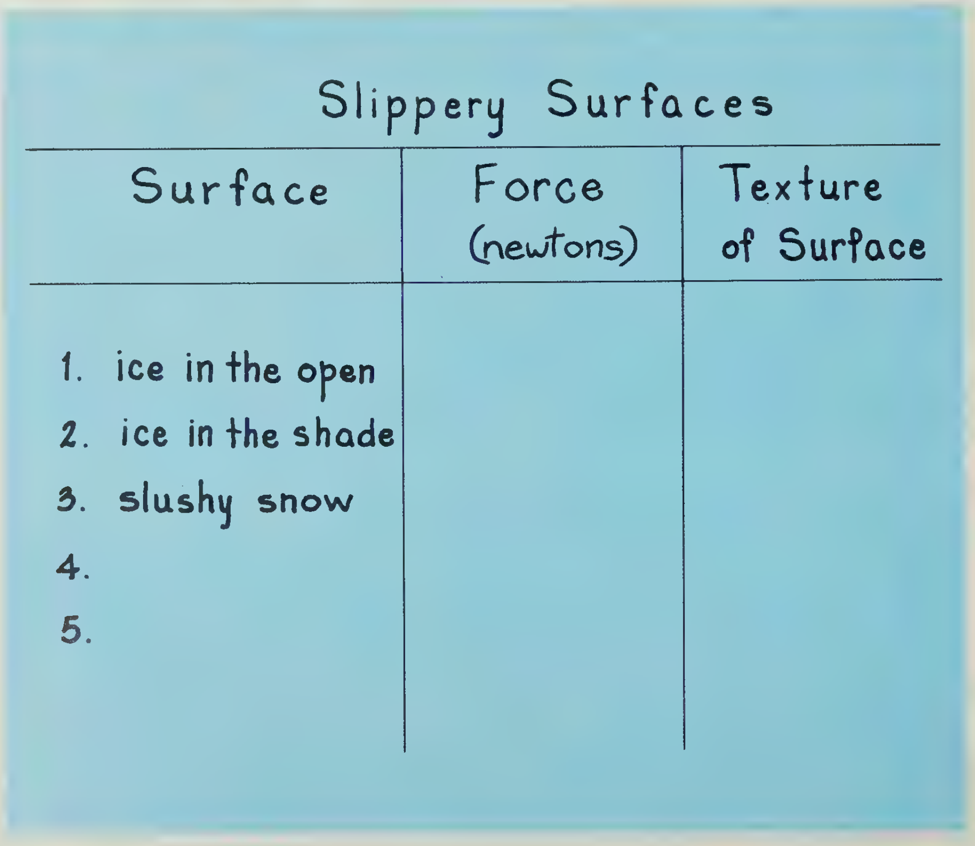
Before you use a spring scale to measure the amount of force required to pull a brick over snow and ice covered surfaces you should consider the following suggestions.

(a) Use a spring scale that is graduated in newtons. The newton is the SI unit of force.

(b) Hold the empty scale in your hand and pull on it so as to get the "feel" of a newton force. This step should be repeated each time you use the device.

(c) Grasp the spring scale by the ring and pull the brick steadily over a surface. Read the newton force indicated on the scale as you are sliding the brick.

What distance should the brick be dragged over each surface?



Slippery Surfaces

Surface	Force (newtons)	Texture of Surface
1. ice in the open		
2. ice in the shade		
3. slushy snow		
4.		
5.		

Slide the brick with an even pull over several surfaces, such as a sheet of ice, slushy snow, bumpy ice, new snow, old snow, loose snow, compacted snow, a frosty surface.

Record your information on a chart similar to the one illustrated.

What other types of toboggans or sliding devices could you use in your experiments?

Digging Deeper

On each surface, you measured the *slideability* of the brick. In more proper terms, you measured the amount of friction between the brick and each surface. Find out what friction means.

Between which surface and the brick was there the least friction? the most friction?

Compare your results with the amount of friction between the brick and other surfaces like asphalt, cement, wood, metal, carpet, and tile.

How did the texture of each surface affect the amount of friction between the surface and the brick?

What other factors seemed to affect the force required to slide the brick over the surfaces that you tested?

For each surface that you tested, decide whether it would be easier to carry the brick or slide it.

Why do you think that curling rinks sprinkle water on the ice surface to create pebbles over which the rocks must move?

Why do the curlers sweep the ice vigorously with a broom when a rock is sliding on the ice?

What is meant by the hockey terms *fast ice* and *sticky ice?*

Branching Out

Find a smooth icy area and divide it into several similar sections. Change each section by adding some other substance to it. You might use salt, sugar, water, wax, ashes, sand, tempera paint, oil, etc. Do not place anything on one of the sections so that it can be compared to the other surfaces. This will be the *control plot.* Use the friction test on each section and graph the results. What reasons can you suggest for any differences in the data that you have collected.

Activity 2 suggests an experiment that can be performed with toboggans. While investigating this activity you will be considering such scientific factors as friction, slopes (inclined planes), weather conditions, and toboggan design. In order to perform this investigation properly you will need a suitable and safe hill, a variety of toboggans, and the cooperation of a group of students and your teacher. You will also be using a time measuring device, such as a stopwatch, a long tape measure, and substances that can be used to wax toboggans. It is important that the activity is well planned before you embark on a field trip to investigate it.

What job will each student have at the bottom of the hill?

Activity 2:

How is the speed of a toboggan affected by the preparation of its under surface?

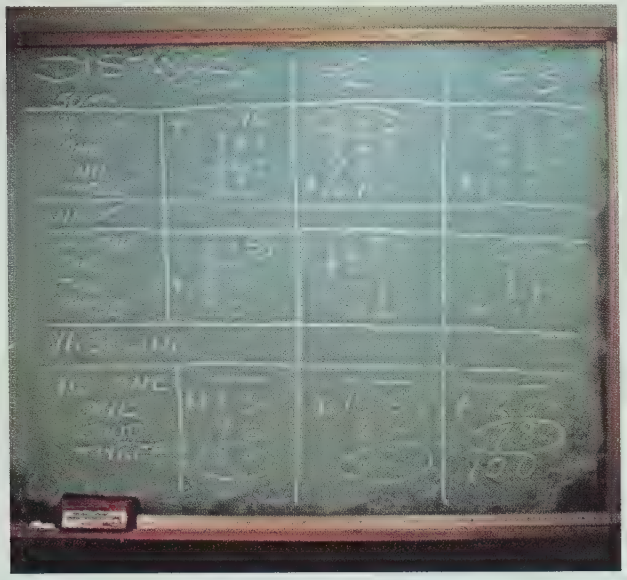
As you investigate this activity many factors will possibly affect the speed of the toboggan: the mass on the toboggan, the material of which the toboggan is made, the shape of the toboggan, the length of the toboggan, the preparation of the under surface of the toboggan, where the riders sit, how the riders sit, the snow conditions on the hill, the slope of the hill, the push to start the toboggan, the distance required for the toboggan to travel, the timing device that is to be used.

This activity stresses the preparation of the under surface of the toboggan. In order to discover meaningful answers this is the only factor that can be changed. It is the *variable* in the experiment. All of the other factors as much as possible must be controlled or kept the same (constant) for each test. Consider each factor and plan how you will control it with your group. If you wish to explore the effect of the other factors on the speed of the toboggan then you will need to reword the purpose and the procedure of the experiment appropriately.

Measure a course from the top to the bottom of the hill of at least 50 m. Mark the starting and finishing points clearly.

Clean the bottom of the toboggan with a cloth to remove any waxes or other materials that may be stuck to it.

What position and stance will the riders use in their other test runs?



The students who compiled this chart have cleverly included three variables? How accurate will their results be? Why would a series of graphs be easier to understand?

In what different ways have you decided to prepare your toboggan?

Use a stopwatch to measure the time required for the toboggan and its riders to complete the course. By making three tests and finding the average time, your results will be more accurate.

Repeat the activity using different materials to coat the underside of the same toboggan. You might test the effects of oil, vaseline, dirt, water, tempera paint, or different types of waxes on the speed of your toboggan. Make sure that proper field records are made for each test run.

Digging Deeper

With which substance was the average speed of the toboggan the greatest? the slowest?

How could you use the word friction to explain the differences in speed?

How would a steeper or shallower slope of the hill affect the speed of the toboggan?

How would colder or milder weather affect your results?

Why do skiers wax their skis?

Choose another factor that you think will affect the speed of your toboggan and design an experiment to test it.

How does the mass of a toboggan affect its speed?

How does the design of a toboggan affect its speed?

How does the material of which a toboggan is made affect its speed?

Ice-skating is a favourite winter sport in many parts of the world. How could you find out how skating was first started? It can be demonstrated that a wire with a mass attached will melt a thin passageway through a block of ice. The same principle is used in making an ice skate work. The mass of the skater causes pressure on the skate blade which melts the ice underneath it. The skate actually glides over a thin film of water on the ice to make skating quite effortless compared to walking or running.

How will the difference in mass of the two skaters affect the ease with which they glide over the ice?

Activity 3:

If you increase the mass on skate blades will the skates glide more easily over the ice surface?

Construct an ice truck from a pair of skates and a wooden box at least 50 cm square and 15 cm deep. A grape box or an old wooden dresser drawer would be ideal.

Securely tie the skates to two opposite sides of the box so that only the blades will touch the ice surface. A belt or a piece of rope can be used to lash the boots of the skates to the sides of the box.

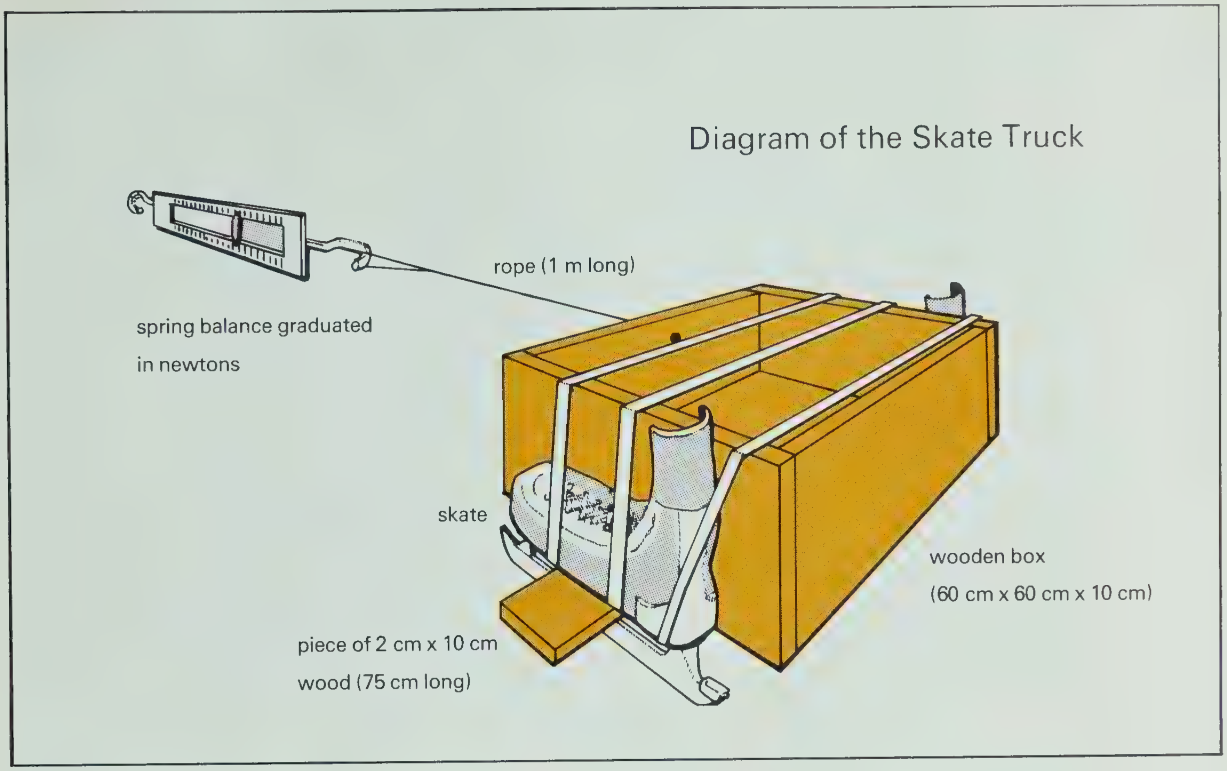


Diagram of the Skate Truck
rope (1 m long)
spring balance graduated in newtons
skate
wooden box (60 cm x 60 cm x 10 cm)
piece of 2 cm x 10 cm wood (75 cm long)

What is the purpose of the 2 cm x 10 cm piece of wood?

Place a piece of wood, 2 cm x 10 cm and longer than the width of the box, between the boot and blade of each skate. The box will rest on this piece of wood without touching the ice.

Attach a 1 m piece of rope to the box at one end and to a spring balance (graduated in newtons) at the other end.

What is the purpose of the 3 cm x 10 cm piece of wood?

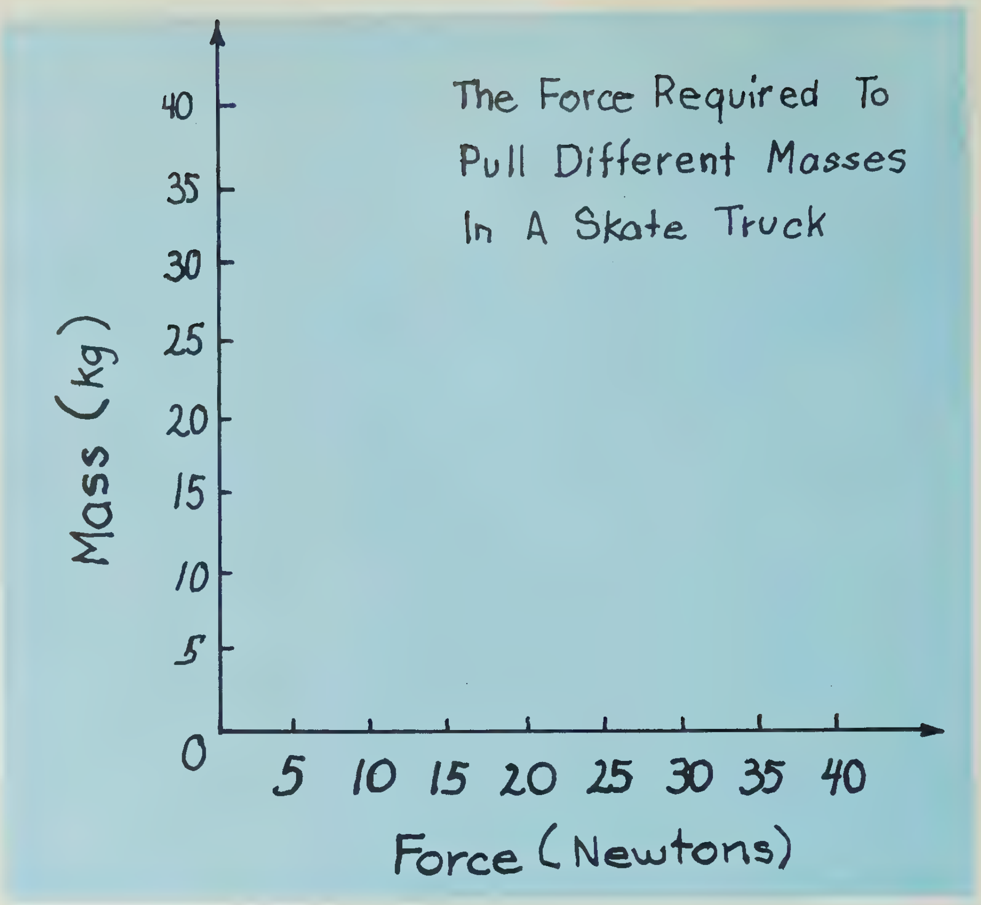
Grasp the spring balance by the ring and slide the skate truck, with an even pull, on a sheet of ice. Observe and record the number of newtons indicated on the scale.

Make three trials and average the results for a more accurate answer.

Repeat the experiment several times increasing the mass in the box by 5 kg each time until you have measured the force required to pull 50 kg. You might use sand, bricks or various objects with a mass of about 5 kg.

What was used for mass in this experiment?

Use your field records and complete a graph similar to the one illustrated.



[illegible]

How did the force required to pull the skate truck change as more mass was added to it?

What force would be required to pull a mass of 25 kg? 80 kg?

Is more force required to start the skate truck moving or maintain its movement after it has started?

Refer to the photograph of the man and the little girl on pg. 84.

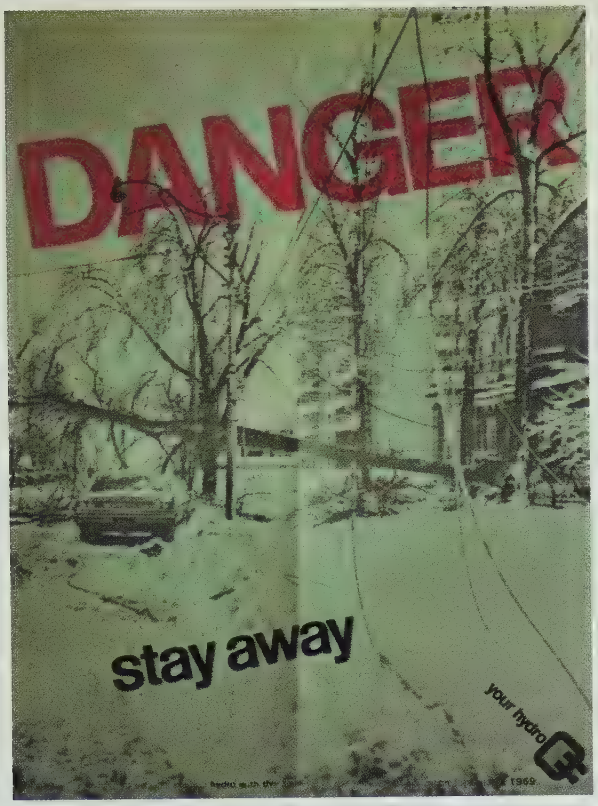
Why would it be unfair to state from the results of your experiment that one of the skaters can skate better than the other?

Devise an experiment to find the force required to stop the moving skate truck with a heavy load, a medium load, a light load.

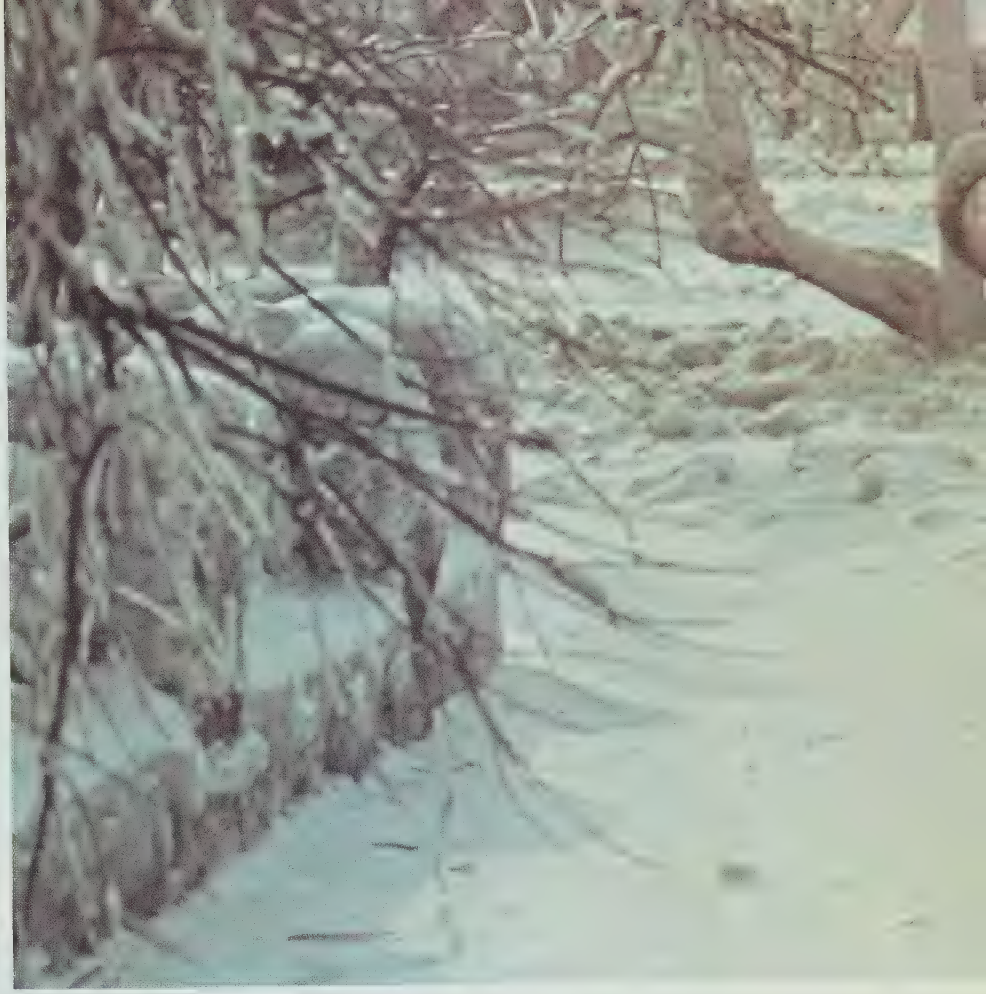
How do sharpened skate blades enable a person to skate better?

How are skates sharpened?

Why do skates seem to become dull more quickly on a frozen pond than on artificial ice?



What dangers can you see in the scene illustrated on this poster?



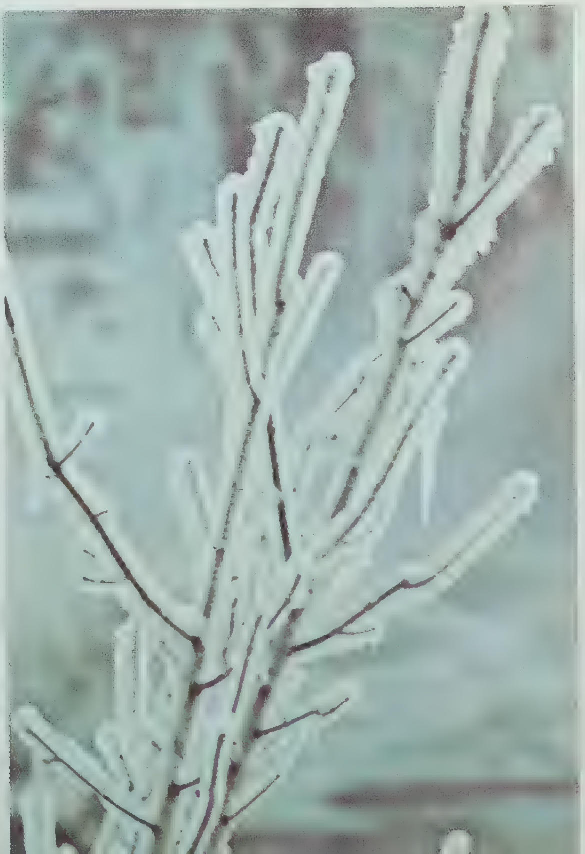
Ice Storms

One of the most beautiful and brilliant winter sights can be seen in the bright sunshine following an ice storm. A thin coating of ice covers everything, trees, bushes, hydro lines.

Such a beautiful scene can be deceiving. Actually, ice does not fall as the expression *ice storm* might suggest. Rain that has cooled, but not frozen, falls and remains as a liquid even far below the freezing point. When this *supercooled* rain comes in contact with a branch, wire or some other cold surface it immediately freezes.

Both rime and glaze ice are formed in this way. Sometimes, however, rime ice can be formed when the tiny water droplets in a fog or steam touch a cold object.

How can you find out what causes the differences between rime and glaze ice?



Rime ice is whitish and rough while glaze ice is smooth and clear like glass. How would you describe the ice coated surfaces in these two photographs?

Activity 4:

How is rime or glaze ice formed?

Crush several ice cubes by wrapping them in a plastic bag, putting them on the floor, and hitting them with a hammer.

Put the crushed ice in a styrofoam cup and add 50 or 60 ml of salt. Stir the mixture.

Insert a small pill vial filled with cold tap water into the crushed ice so that the rim of the vial is just above the ice.

Place a thermometer in the pill vial and stir the water gently until the temperature drops to 3°C.

Leave the thermometer in the pill vial so that it can be read without touching it.

Do not disturb the cup, vial or thermometer even slightly.

Observe the temperature of the water until it drops to several degrees below freezing.

Drop a part of a toothpick in the vial and observe what happens to the water and the temperature.

You might use diagrams to record the results.

Digging Deeper

What caused the temperature of the water to drop below the freezing point?

Why do you think that water does not always freeze when its temperature is below the freezing point?

What happened to the temperature of the water when the piece of toothpick was dropped into the vial?

Describe the type of ice and how it formed.

Branching Out

How are the results of this experiment similar to the formation of rime and glaze ice?

Use reference books on flight and aircraft from your library to discover what causes the layers of ice that sometimes form on the wings of aircraft during a flight and how airplanes are equipped to solve this problem.

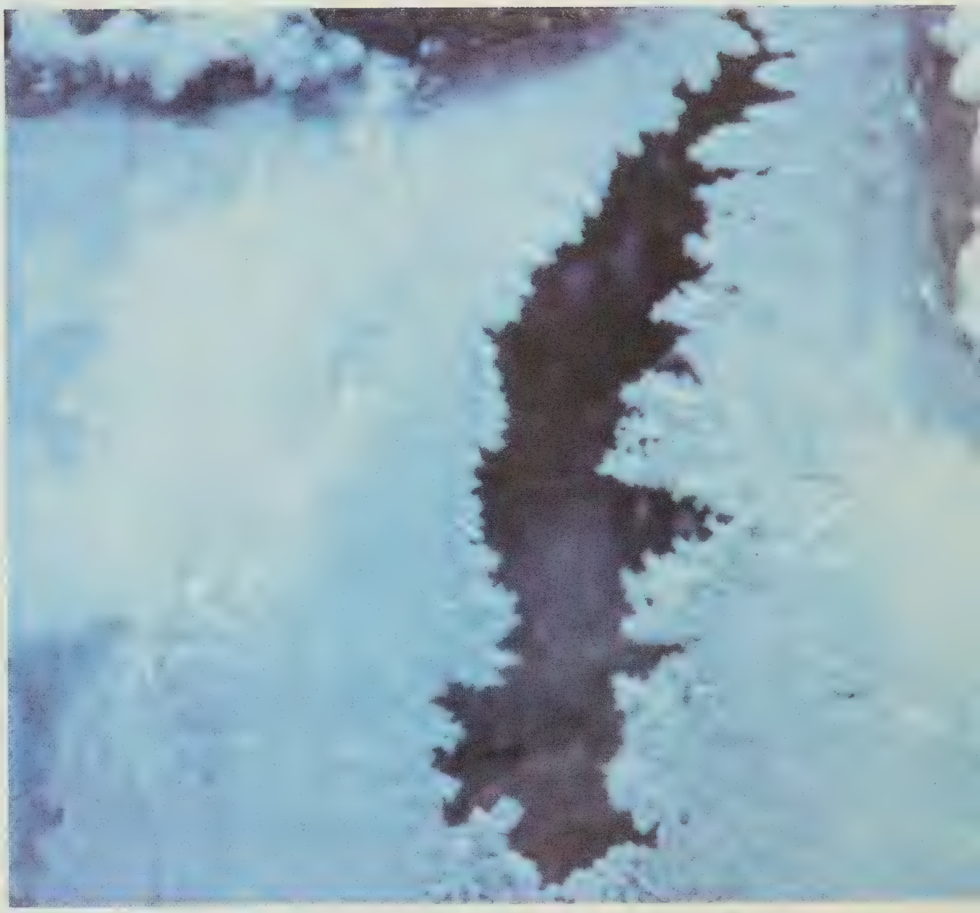
Why was it important not to disturb the container until the proper time?

A Winter Carnival

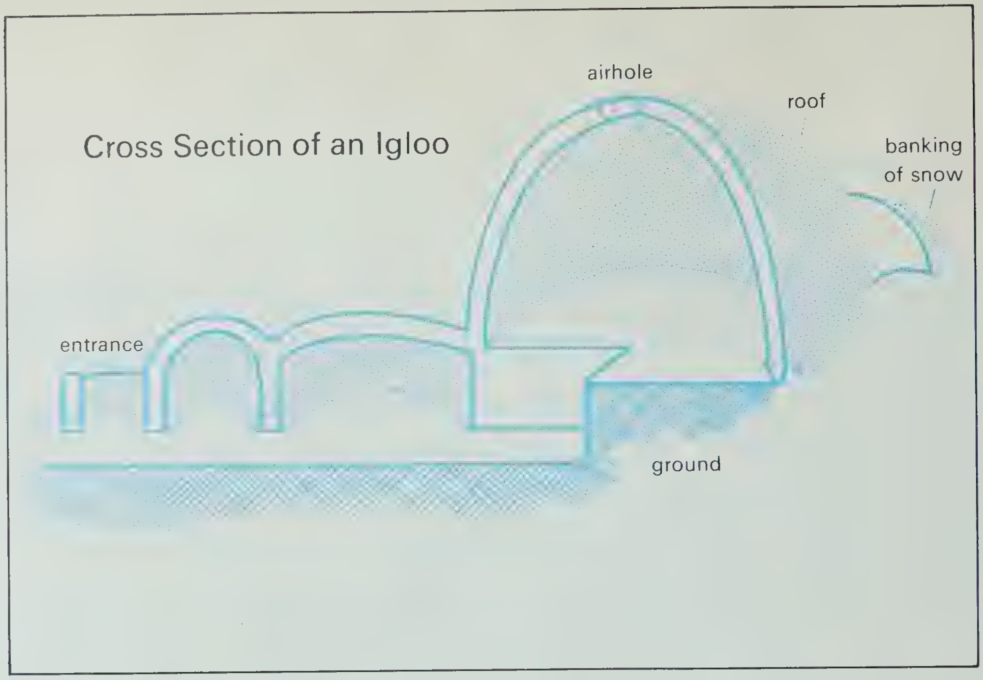
6

6. A Winter Carnival

As snow and ice change the appearance of land surfaces, they provide excellent examples of artistic sculpture. A winter walk for the observant nature lover will unveil many beautiful and fascinating shapes. Study the following photographs and look for the beauty in the interesting formations.



No doubt, the beauty that winter exhibits has inspired people to organize winter carnivals in which activities, contests, and games suitable to the season are conducted outdoors. The purpose of this chapter is to encourage you to participate in the excitement of winter so that you can learn to appreciate it not only from a scientific but also from an artistic and recreational point of view. You might want to organize a winter carnival for your school. If you do, the following activities may be suitable, but you can find more in other resource books or you can create some activities of your own.


Cross Section of an Igloo

Snowhouses

You have probably seen pictures of an Eskimo igloo and most of us have tried to make one with varying degrees of success.

It is possible to have a temperature well above freezing inside a properly constructed igloo even when the temperature outside is much colder. The first activity challenges you and your classmates to see who can make the most comfortable snowhouses.

Activity 1:

How warm can you make a snowhouse?

Form a small group of interested students and construct a snowhouse. You will have to consider the merits of different types of snowhouses. Don't hesitate to be an inventive architect.

When you have finished your snowhouse, leave a maximum-minimum thermometer hanging from the ceiling so that it will measure the high and low air temperature over a 24 h period. If this is not possible, take the air temperature in the snowhouse on the day following its construction.

What care should be taken with a maximum-minimum or regular thermometer?

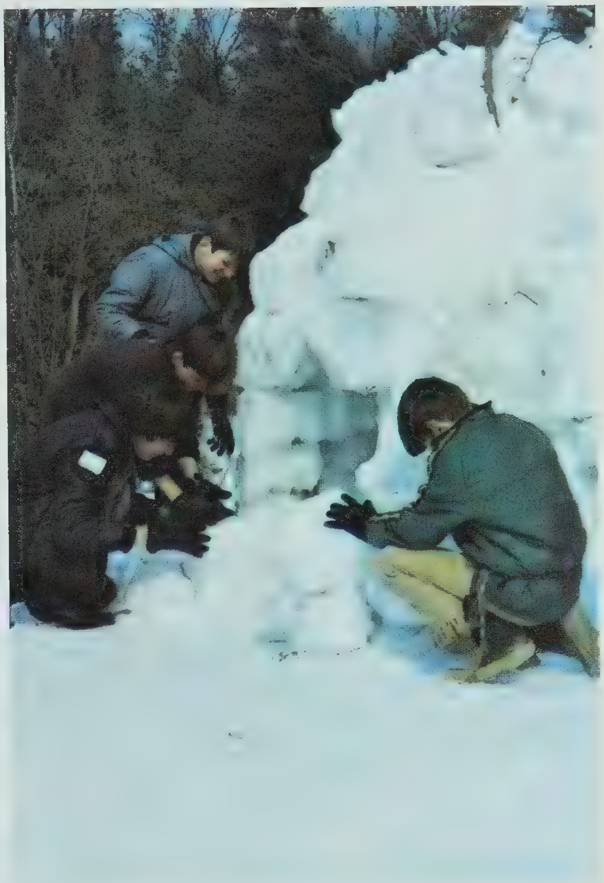
This snowhouse was made by shovelling out a bank of snow.

How does the air temperature near the roof of the snowhouse compare to the air temperature near the floor?

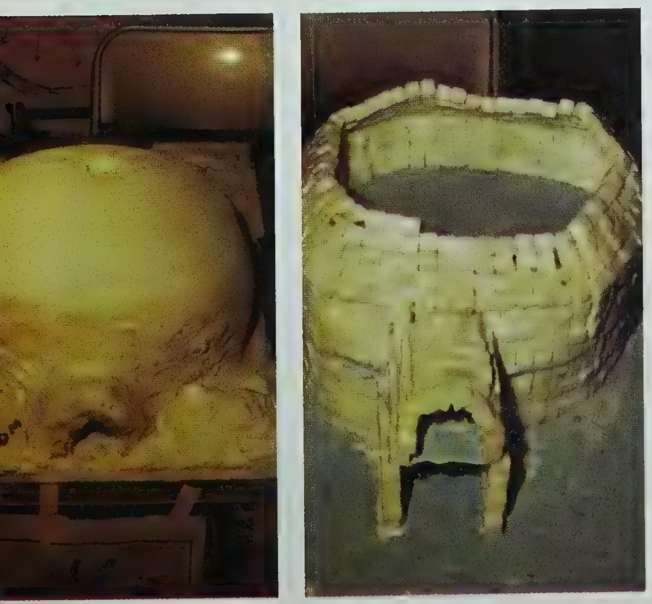
If several groups of students make snowhouses at the same time, you could have an interesting contest to see which group has made the most comfortable one. Some guidelines that you might use to judge the snowhouses are: the air temperature at the ceiling, the roominess inside, how easy it is to enter, the appearance, the amount of melting on the inside walls.

As a follow up activity you might use books and films from your school or local library to find out how Eskimo igloos are made and used. One book that contains several ideas for snow dwellings is called *Arctic Shelters* and is available from the Queen's Printer in Ottawa, Ontario.

Models of igloos can be easily made in your classroom.



How is this group of students constructing their snowhouse?



Sugar cubes and plaster of Paris are good media for making models.

Some students made a diorama of an arctic scene.

Snow Sculpturing

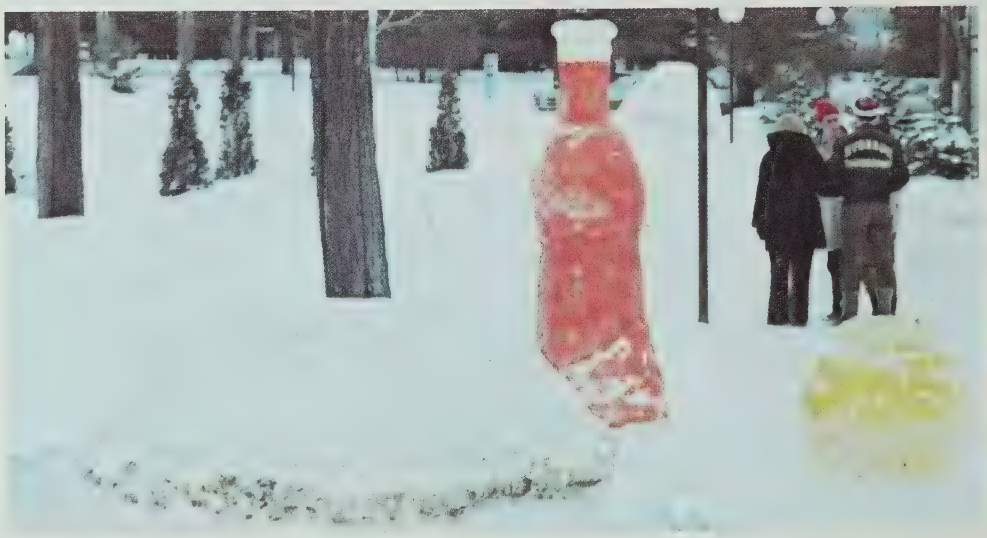
A central part of most winter carnivals is the creating of snow and ice sculptures. Some people take their tasks quite seriously and use several clever techniques to improve their masterpieces. Study the following samples of snow and ice sculpturing made by students to discover their techniques.

Activity 2:

How can snow and ice be used to make interesting sculptures?

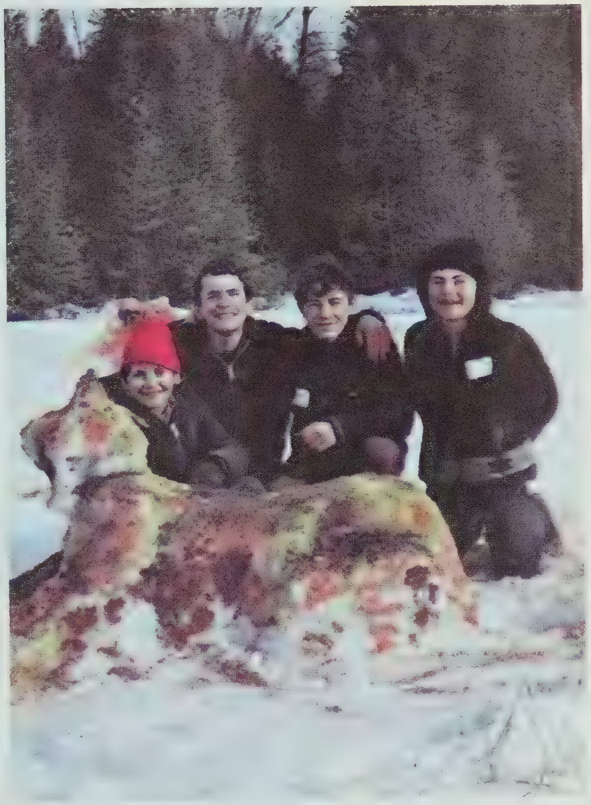
Use your imagination to decide on an unusual subject for your snow and ice sculpture. You might want to work with a small group of two or three students. Gather the materials that you will require, such as a spray bottle of water, food colouring or tempera powder, a garden trowel, a shovel, and a knife. Find an area where there is plenty of snow and proceed to create your work of art. The most important thing to remember is to use your imagination to plan and make a life-size but durable figure that will be pleasing to you.

How did the students who made these figures use colouring, icing and cutting techniques?



For some ideas, study the following figures made by junior sculptors.

What other equipment do you plan to use?



You might depict something in real life.

Abstract figures are very interesting too.

For a different type of ice sculpturing, study the following photographs.

The ice formations were made on an ice tree. Try Activity 3 for a simple method of making an ice tree.

Activity 3:

How can interesting ice formations be made on an ice tree?

This activity should be conducted during very cold weather which is expected to last for some time.

Stake a used Christmas tree securely into the ground or tie it to a post. Do not use a live tree for this experiment since ice can seriously damage it.

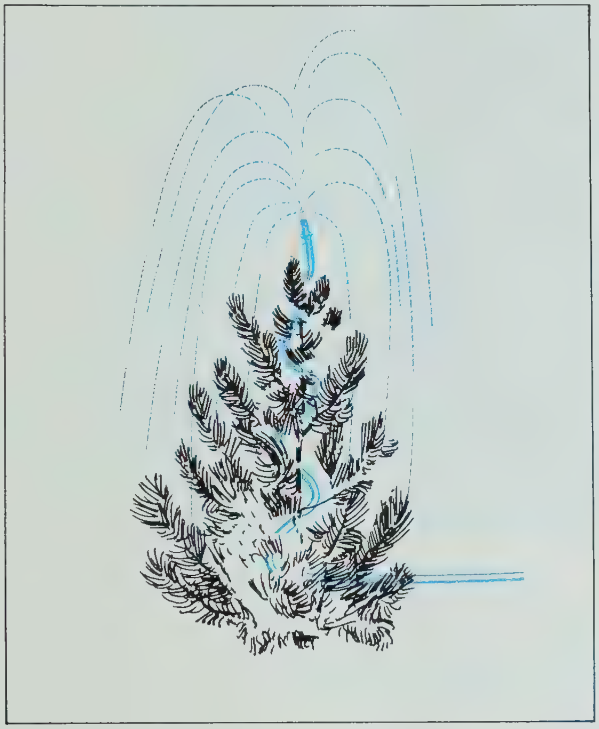
Attach a garden hose with an adjustable spray nozzle along the length of the tree trunk with pieces of string.

It is very important that you use caution in using tap water outdoors during the winter since water will freeze and the expanding ice will easily burst the water pipes.

Turn on the hose so that a fine spray falls on the tree. During the day when the temperature is warmer, turn down the faucet so that the water just trickles out of the nozzle. As long as the water is moving in the hose, it will not freeze. At night, if you wish to make more ice, you can turn up the spray.

When you have made as much ice on your tree as you wish, turn off the water from inside the house or building.

Several adjustments might be needed before the spray is just right.



Empty as much water from the hose as possible outside and take the hose indoors to prevent it from freezing. Leave the outside tap on so that water will not be trapped between the inside and outside faucet.

If your area has winters with long periods of subfreezing weather your ice tree could last for a large part of the winter.

If you obtain the type of outdoor floodlight that some people use on their lawns during the Christmas season and place it on one of the branches of your ice tree, it will cast beautiful reflections through the ice formations.

You could also colour your ice tree with food colouring or tempera powder to make an unusual and original decoration for the holiday season.

What could you add to your ice tree to make it more decorative?

Winter Refreshments

No outdoor event during the winter would be complete without refreshments. Some popular winter snacks are hot chocolate, hot dogs cooked on a barbecue, and marshmallows roasted on a campfire. You might even research how to make maple syrup taffy when the sap is running in sugar maple trees during late winter. Since this book has been mostly concerned with snow and ice, the final activity will guide you to making your own ice cream, a tasty treat on a cold day.

Before refrigeration and freezer units were perfected to the point that ice cream could be mass-produced and kept cold in local stores inexpensively, people used to make their favourite ice cream recipes at home in hand-turned freezers.

Many of these old-fashioned units are still available and have been collected by people interested in antiques. If you could borrow a hand-turned freezer, you will have an unusual experience in preparing your homemade ice cream.

Many good cookbooks include a large variety of ice cream recipes. Some even suggest how you can make each recipe in the hand-turned freezer as well as in the mechanical refrigerator that you have at home. Look in the "Frozen Desserts" section of a cookbook.

Activity 4:

How can homemade chocolate ice cream be prepared?

You will need the following ingredients:

10 ml gelatin
250 ml milk
1 ½ squares bitter chocolate
30 ml cold water
500 ml whipping cream
200 ml sugar
2 ml salt
5 ml vanilla

Soften the 10 ml of gelatin in the 30 ml of cold water.

Heat the 250 ml of milk in a saucepan until it is scalding and add the chocolate that has been cut up finely.

Reheat this mixture just to the boiling point and add the gelatin, salt, and sugar stirring until the ingredients are dissolved.

Whip the cream and add it and the vanilla to the mixture.

Pour the mixture into an empty ice cube tray and place it in the freezer compartment of a refrigerator. Turn the temperature control to the coldest point possible and leave the tray in the freezer until it is ready to serve.

This recipe will serve five people. If you wish to serve a larger group increase the ingredients accordingly.

A tasty treat!

Branching Out

A recipe for making snow ice cream.

The ingredients are:

fresh clean snow
fruit juice or
cream, sugar and vanilla extract

Arrange the clean snow loosely in a bowl.

Pour the fruit juice over the snow. Instead of fruit juice, you might use a mixture of cream, sugar and a few drops of vanilla extract. This mixture can be poured over the snow.

Your snow ice cream is ready to eat.

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Glossary

Anemometer: An instrument used for measuring wind speed.

Classification system: An arrangement of objects into groups according to their properties for purpose of easy identification.

Condensation: The changing of vapour into a liquid.

Control: A standard of comparison used when observing the results of an experiment.

Cornice: The overhang or shelf on a snowdrift that has been caused by wind patterns.

Evaporation: The conversion of liquid into a vapour.

Field of vision: The area that can be viewed through an optical instrument, and which depends partially on the power of the lens used.

Freezing rain: Supercooled (cooled below the freezing point without changing into solid form) rain which freezes immediately upon touching a cold surface.

Friction: The resistance to movement when a surface is moved over another surface.

Glaze ice: A glassy, smooth ice resulting from freezing rain.

Hard water: Water with a considerable amount of minerals dissolved in it.

Leeward: The side or part of an object which is sheltered from the wind; the direction in which the wind is blowing.

Maximum-minimum thermometer: An instrument that registers the highest and lowest temperatures that occur in a certain period of time.

Meteorologist: A scientist who studies the earth's atmosphere, weather and climates.

Phenomenon: An event or object of scientific interest that can be observed in nature.

Rime ice: A bumpy, whitish ice resulting from supercooled water freezing in small particles when contacting a cold surface.

Snow gauge: An instrument used to measure the amount of snowfall.

Snowstick: A stick graduated in centimetres used to measure the amount of snowfall.

Soft water: Water that is relatively free of mineral salts.

Standardized reading: A recording from a measuring device that has been adjusted to account for inconsistencies among various instruments used.

Variable: A changeable factor in an experiment.

Wind chill factor: The degree to which wind appears to lower the air temperature.

Windward: The side or part of an object which faces toward the wind; the direction from which the wind is blowing.

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